
CLAIMS

[Claim(s)]
[Claim 1] The approach which supplies a subcarrier, carries out the frequency modulation of the subcarrier with the channel signal block by which amplitude modulation was carried out, and is characterized by consisting of a process which transmits this FM modulation subcarrier to an optical-communication path by the approach for transmitting signal transmission through an optical-communication path.
[Claim 2] The approach characterized by being RF subcarrier used for carrying out intensity modulation of the optical subcarrier for transmitting said FM modulation subcarrier through said communication path in the application-for-patent term 1.
[Claim 3] The approach further characterized by including the process changed into the frequency range which carries out suitable [of said FM modulation RF subcarrier] for the modulation of said optical subcarrier in the application-for-patent term 2.
[Claim 4] The approach which receives the optical subcarrier by which intensity modulation was further carried out from said optical-communication path in the application-for-patent term 3, and is characterized by to include the process which carries out FM recovery of the RF subcarrier in order to change said frequency-modulation RF subcarrier into the frequency range which carries out suitable in order to restore to ejection and taken-out RF subcarrier by which frequency modulation was carried out from the optical subcarrier which received and to take out the aforementioned channel signal block by which amplitude modulation was carried out.
[Claim 5] The approach characterized by including the process which carries out FM recovery of the RF subcarrier in order to receive the optical subcarrier modulated from the further aforementioned optical-communication path in the application-for-patent terms 1-3 and to take out the channel signal block with which amplitude modulation of ejection and the above was carried out in the aforementioned RF subcarrier by which frequency modulation was carried out from the optical subcarrier which received.
[Claim 6] It is the approach characterized by being the optical subcarrier which contains an optical frequency modulated wave between the modulation processes of the above [the aforementioned FM modulation subcarrier] in the application-for-patent term 1.
[Claim 7] It is the approach characterized by carrying out direct modulation of the aforementioned optical subcarrier with said AM channel signal block in the application-for-patent term 6.
[Claim 8] The aforementioned optical subcarrier is an approach characterized by the frequency modulation RF subcarrier which carries the channel signal block with which amplitude modulation of the above was carried out in the application-for-patent term 6 becoming irregular.
[Claim 9] Equipment characterized by including the means for carrying out the frequency modulation of the subcarrier with the channel signal block by which amplitude modulation was carried out, and the means for transmitting a frequency modulation subcarrier through an optical-communication path with the equipment for transmitting signal transmission through an optical-communication path.
[Claim 10] It is equipment characterized by for said FM modulation subcarrier being an RF subcarrier, and said transmission means including the means for carrying out intensity modulation of the optical subcarrier by RF subcarrier by which FM modulation was carried out in order to transmit through the aforementioned communication path in the application-for-patent term 9.
[Claim 11] Equipment further characterized by including the means for changing the aforementioned RF subcarrier by which FM modulation was carried out into the frequency range which carries out suitable for

the intensity modulation of said optical subcarrier in the application-for-patent term 10.
[Claim 12] It is equipment characterized by including the means for inputting the aforementioned channel signal block by which amplitude modulation was carried out into the voltage controlled oscillator of a couple by which the means of said frequency modulation and conversion was connected to the push pull mode of operation in the application-for-patent term 11, and the oscillator of this couple, and the means of the double balance mixer connected to the output of an oscillator in order to supply RF subcarrier from which the above was changed.
[Claim 13] It is equipment characterized by the aforementioned voltage controlled oscillator operating in the application-for-patent term 12 in a microwave frequency range.
[Claim 14] It is equipment characterized by for said subcarrier being an optical subcarrier and said modulation means carrying out direct modulation of the optical frequency of a subcarrier with AM channel signal block in the application-for-patent term 9.
[Claim 15] It is equipment characterized by including the means for combining said two or more modulation subcarriers in order for the aforementioned frequency modulation means to modulate each of two or more separate subcarriers in the application-for-patent term 14 with the separate channel signal block by which amplitude modulation was carried out and to transmit said equipment through the further aforementioned optical-communication path.
[Claim 16] It is equipment which said FM modulation subcarrier is an RF subcarrier in the application-for-patent term 9, and is characterized by including the means for carrying out the frequency modulation of the optical subcarrier by the FM modulation RF subcarrier in order to transmit to said transmission means through said communication path.
[Claim 17] It is equipment which the frequency modulation of each of two or more separate optical subcarriers is carried out in the application for patent term 16 by the separate FM modulation RF subcarrier which superimposes the separate channel signal block by which amplitude modulation was carried out , and is characterized by include a means combine two or more aforementioned frequency modulation light subcarriers in order to transmit said equipment through said optical communication path further .
[Claim 18] The equipment characterized by to consist of the means for receiving the optical subcarrier which has held the frequency-modulation RF subcarrier modulated with an amplitude-modulation channel signal block with the equipment of the receiver for taking out the channel signal block by which amplitude modulation was carried out from an optical subcarrier, and by which intensity modulation was carried out from an optical-communication path, a means for taking out a frequency-modulation RF subcarrier from an optical subcarrier, and a means for carrying out the FM recovery of the RF subcarrier which took out in order to take out an amplitude-modulation channel signal block.
[Claim 19] Equipment characterized by including the means connected between the means of the aforementioned ejection, and said FM recovery means in order to change the frequency modulation RF subcarrier taken out further into the frequency range which carries out suitable for a recovery in the application-for-patent term 18.
[Claim 20] The approach characterized by consisting of a process which becomes irregular in order to generate an optical subcarrier and to generate the signal transmission by which the optical frequency modulation was carried out with AM subcarrier block in the optical frequency of this optical subcarrier, and transmits optical frequency modulation signal transmission through an optical-communication path by the approach for transmitting signal transmission through an optical-communication path.
[Claim 21] The approach which receives an optical frequency modulation subcarrier from said optical-communication path, and is further characterized by including the process which takes out AM subcarrier block from the optical subcarrier which received in the application-for-patent term 20.
[Claim 22] Equipment characterized by consisting of an optical FM discriminator for making a means for the equipment of the receiver for taking out an amplitude modulation channel signal block from an optical frequency modulation subcarrier receiving the optical subcarrier by which frequency modulation was carried out with an amplitude modulation channel signal block, and the lightwave signal by which intensity modulation was carried out with ejection and said AM channel signal block in the amplitude modulation channel signal block from the optical subcarrier which received output.
[Claim 23] Equipment characterized by including the means for changing the further aforementioned intensity modulation lightwave signal into RF subcarrier including said AM channel signal block in the

application-for-patent term 22.
[Claim 24] It is equipment characterized by taking out the amplitude modulation channel signal block of the inside which said FM discriminator was modulated by FM channel signal block in the application-for-patent term 22, and carried out intensity modulation of the aforementioned lightwave signal by said RF subcarrier.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Background of the Invention] This invention relates to transmission of an amplitude modulation (AM) signal, especially the cable television band signal by which amplitude modulation was carried out to the optical-fiber line network through an optical-communication path.
[0002] Development of an analog optical transmission system is attracting the interest of a world dramatically in recent years, and an analog communication system has the advantage which can utilize bandwidth efficiently as compared with a digital system. This will work advantageously especially for cable television (CATV) communication system with the need of transmitting the image channel of a large quantity to an optical fiber. Moreover, the equipment present by using the same amplitude modulation vestigial sideband (AM-VSB) signal format as being used by the coaxial cable signal transmission can be shared as it is.
[0003] If the television signal which consists of an AM-VSB image subcarrier is adopted, the number of channels can be increased in the bandwidth which was compatible in the format with the NTSC television standard, and was permitted, and a desirable thing will be seemed. However, it is that a carrier-to-noise ratio (CN ratio) is required more by the high level one of the faults of AM-VSB transmission compared with the frequency modulation of a video signal, or other technique like digital transmission. Usually, in order to receive an AM-VSB television signal clearly, at least 40dB CN ratio is required.
[0004] In order to transmit an information signal (for example, television signal) through an optical fiber, a light beam (subcarrier) must be modulated with the information signal. It is thought that things which the semiconductor laser which each has an advantage and a fault and shows enough linearity and dynamic ranges to transmission of the amplitude modulation subcarrier image of a multiplexer channel with a technique at present comes to hand although the various approach against the well-known approach was made, such as direct modulation of the laser from the light source or external modulation of a laser beam, are difficult.
[0005] A multiplexer-channel CATV system must supply 40 or the number of channels beyond it, in order to remain by commercial-scene competition. I hear that it is difficult for the trouble accompanying this multiplexer-channel AM transmission for the CN ratio and distorted component as a requirement of AM transmission to attain in an optical transmission system, and it has it.
[0006] In frequency modulation (FM), the CN ratio and distorted component as a requirement may be lower. Multiplexer-channel image transmission was transmitted by each subcarrier of many FM modulation image channels at the beginning. However, the technique of this FM subcarrier modulation for image distribution will need a demodulator as well as a modulator and a receiving side under exclusive contract by the transmitting side to each channel, respectively, and will require costs. Furthermore, in order to make it compatible with the present cable system, in such FM transmission, frequency conversion must be carried out for suitable channel distribution, and the complicated system which uses many components for this reason will be needed.
[0007] It will be useful to offer the low CN ratio which is the requirement of FM transmission, the approach accompanied by the advantage of a distorted component, and equipment, reconciling the advantage of AM signal distribution. It will be still more useful if the receiver for receiving the signal transmitted using such an approach can be offered. This invention offers such an approach and equipment.

[0008]
[Summary of the Invention] This invention offers the approach of transmitting signal transmission to an optical-communication path. It is used for the usual (amplitude modulation AM) channel signal block carrying out the frequency modulation of the RF subcarrier. And it becomes irregular by the frequency modulation subcarrier, and an optical subcarrier is transmitted to an optical-communication path like an optical fiber. In the 1st example, the intensity modulation which modulates an optical subcarrier by the frequency modulation subcarrier including an AM signal block is used.
[0009] In order to make signal processing easy, RF subcarrier by which frequency modulation was carried out is changed into the frequency range for the modulation of an optical subcarrier which carries out suitable. For example, this subcarrier is changed into the low frequency range which can share an optical transmission system device like an optical transmitter and an optical receiver after performing the frequency modulation of RF subcarrier with an amplitude modulation channel signal band in a microwave frequency range.
[0010] The receiver used in this 1st example receives the optical subcarrier by which intensity modulation was carried out from the optical-communication path, and if required because of the recovery which restores ejection and AM channel signal block, it will change RF subcarrier by which frequency modulation was carried out from this subcarrier into the frequency range which carries out suitable. It comes out picking, and the bottom, a signal block is inputted into a television set or other transmission systems, and is recovered from it to selected AM channel signal.
[0011] The means for transmitting the optical subcarrier modulated to an optical-communication path like the means which carries out the frequency modulation of the RF subcarrier with the channel signal block by which amplitude modulation was carried out, a means to modulate an optical subcarrier by RF subcarrier, and an optical fiber is included in the equipment for transmitting signal transmission in the 1st example. A conversion means is changed into the frequency range which carries out suitable [of the RF subcarrier by which frequency modulation was carried out for the intensity modulation of an optical subcarrier]. Frequency modulation and a conversion means consist of voltage controlled oscillators of a couple connected to the push pull mode of operation.
[0012] The channel signal block by which amplitude modulation was carried out inputs into an oscillator pair, and the frequency modulation RF-signal band from which the means of the double balance mixer connected to the output of an oscillator was changed is supplied. Since a voltage controlled oscillator is operated in a microwave frequency range in order to improve the linearity of frequency modulation, the channel signal block by which amplitude modulation was carried out in this case occupies the **** element in about 20GHz subcarrier.
[0013] The receiving set of the 1st example consists of means to receive the optical subcarrier containing RF subcarrier by which frequency modulation was carried out with AM channel signal block from the optical-communication path by which intensity modulation was carried out. In order to take out the means for taking out RF subcarrier by which frequency modulation was carried out from an optical subcarrier, and an amplitude modulation channel signal block, the means for carrying out FM recovery of the subcarrier is equipped. In order to change the taken-out frequency modulation subcarrier into the frequency range for a recovery which carries out suitable, the means connected between the reinstatement means and FM recovery means is also equipped. Moreover, a means to supply the restored amplitude modulation channel signal to a television set or similar equipment is also equipped.
[0014] It is used for AM channel signal block modulating the optical frequency of an optical subcarrier in the 2nd example. The reference of the optical subcarrier is absolutely carried out to the vibration frequency value, and this is the need in order to operate a discriminator proper by the receiver side. The channel signal block by which amplitude modulation was carried out from the optical subcarrier which received as a receiving set to an optical frequency modulating signal in the 2nd example consists of optical FM discriminators which output ejection and a corresponding intensity modulation lightwave signal. Moreover, the receiver is equipped also with the means for restoring to the channel signal which consists of an image and speech information and by which amplitude modulation was carried out.
[0015]
[Example] In order that this invention may transmit an optical subcarrier through an optical-communication path, it is the block of the usual AM channel signal, and the advantage which can attain a low CN ratio and a distorted component is born by carrying out FM modulation of the RF subcarrier. If an optical subcarrier

is equipped with the linearity of the moderate laser circuit for FM transmission, and the conditions of a CN ratio, and is supplied from laser, for example, about 18dB of CN ratios becomes, it will be enough for FM transmission, and will only be needing the 2nd and about 20dB of the 3rd compound distorted components. This is completely advantageous as compared with the about 40dB CN ratio needed for AM transmission.
[0016] Although this invention is related to fiber-optic cable television systems and explained, if it is the people well versed in the technique, it will be able to admit that this invention is applicable to other optical-communication networks.
[0017] The example of the beginning of invention is illustrated from drawing 1 to drawing 4 . From about 50 to about 550MHz, the channel signal of each [6MHz frequency allocation] is included in the present AM cable television band 10 so that clearly [in drawing 1], and it can expect that bandwidth is extended up to about 1 GHZ in the future. The present frequency band 10 is inputted into the block converter 14 from a terminal 12.
[0018] In this invention, the broadband VCO to the frequency (for example, 2.2GHz) for modulating RF subcarrier with AM cable band is included in the block converter 14. As for the frequency modulation by AM cable band, it is advantageous that the band of the range of microwave performs, and the bandwidth of a block of a television subcarrier is [in this case / the actuation frequency of a voltage controlled oscillator] small.
[0019] After the filter of the FM modulation subcarrier is carried out with a low pass filter 18, it carries out direct modulation of the laser 22. The limit by the requirement and optical-fiber circuit of communication system is followed, and it is FABURI. - The laser of common knowledge structure like the Perrault form, a distribution feedback form (DFB), or quantum Igata is used. Of course, external modulation or other intensity modulation can be used for the modulation of this lightwave signal.
[0020] the example of drawing 1 -- FABURI - the Perrault rhe -- the -- intensity modulation of -22 is carried out by RF subcarrier containing a band 20. Consequently, the optical subcarrier including the block of a television channel signal by which intensity modulation was carried out is generated, and it is transmitted to the optical Ferber receiver 26 through the optical Ferber network 24. So, the optical subcarrier output from laser 22 contains AM cable band of the origin by which FM modulation was carried out in the high frequency field, and will transmit an intensity modulation signal through an optical-communication way. such -- dividing -- coming out -- an intensity modulation signal -- optical-AM/RF-FM/RF- an AM signal -- or if it says simply, it can be regarded as AM/FM/AM signal.
[0021] The optical-fiber receiver 26 is common equipment for receiving an optical subcarrier and taking out the information (in this case, it being RF subcarrier (FM/AM) including the block of AM channel signal by which FM modulation was carried out) by which intensity modulation was carried out. The taken-out information is inputted into the block demodulator of 28, is changed into a higher frequency on the local oscillation frequency applied from a terminal 32 by the mixer 30, and takes out the original AM band by the broadband discriminator 34. Upper part conversion of FM / AM signal frequency is advantageous especially when a tuning circuit discriminator is used for the ejection of AM band. Taken-out AM cable band 10 is outputted from a block demodulator.
[0022] The block diagram of drawing 2 has illustrated one of the examples of a broadband VCO 16. It is operated with the center frequency which is about 21GHz which can be satisfied with this example of the linearity of the AM signal block inputted with the terminal 12 in order to modulate the subcarrier by which connected with push PURUMO-DO and the voltage controlled oscillators (VCO) 40 and 42 of a couple were made from VCO. It is clear 500MHz bandwidth's of the AM band 10 to fit in the VCO clock frequency of about 21GHz easily.
[0023] It is combined with the double balance mixer 44, and the output of VCO40 and VCO42 transforms the frequency of an FM modulation RF subcarrier caudad so that both optical transmitter in the existing communication system and receiver can be shared. This RF subcarrier is used for the direct modulation of laser 22. FM modulation subcarrier output outputted with the microwave carrier frequency of 21GHz from VCO 40 and 42 is heterodyne-ized by the mixer 44, and makes the signal band 20 whose center frequency which was illustrated to drawing 1 is about 2.2GHz. A high frequency component is removed from the cycle taking-out force of Broadband VCO with a low pass filter 18.
[0024] The straight-line relation 50 between the input voltage in the output of the double balance mixer 44 and an output frequency is illustrated to drawing 3 . Moreover, the ideal transfer characteristics of the result of having performed push PURUMO-DO of VCO 40 and 42 to drawing 4 are illustrated. Similarly the

line 54 expresses the deviation to a lower part for the deviation to the upper part of a main cycle [as opposed to change of input voltage in a line 52] again.
[0025] At a receiver side, an amplitude modulation channel signal block is taken out by the broadband FM discriminator 34 (drawing 1). This discriminator is the thing of the type of common knowledge like an easy low pass filter which identifies that transition state, can use the double balance VCO of the structure same on the other hand again as a broadband VCO 16 for FM discrimination by the side of a receiver, and also it may use the RF FM discriminator of other common knowledge.
[0026] Another example by this invention is illustrated from drawing 5 to drawing 10 . In this example, AM subcarrier (for example, image) block information is distributed to the optical fiber using an optical frequency modulation. In the arrangement shown in drawing 5 , the laser subsystem supplies the optical subcarrier. The optical frequency modulation of the subcarrier output from the laser subsystem 60 is carried out with AM subcarrier block 120 inputted with a terminal 63.
[0027] The optical subcarrier by which the vibration frequency modulation was carried out is amplified with a light amplifier 62, and is inputted into a splitter 64, and this output is connected to fiber-optic cable television transmission Aminaka's separate transmitting path [each]. In the path shown in drawing 5 , the subcarrier by which FM modulation was carried out optically reaches the vessel 68 according to light valve through the fiber circuit 66, and takes out AM subcarrier from an optical subcarrier.
[0028] it is possible to utilize the technique of the vessel according to light valve of common knowledge like an optical delay circuit, a light filter, an unbalance RF interferometer, a wave division multiplex grid, and (or) a dielectric film as a vessel according to this light valve. The output of the vessel 68 according to light valve is detected by the usual photodetector 70, and is changed into an electric field. The acquired electrical signal is amplified with the RF amplifier 72, and it restores to it to each AM subcarrier by the usual approach.
[0029] Mach illustrated to drawing 9 as an example of the vessel according to light valve used for the example of drawing 5 - A TSUENDA-interferometer type light vibration frequency discriminator is raised. An optical vibration frequency modulation light from the fiber circuit 66 inputs with a terminal 140, and is divided into two paths 142 and 144 of inequality length. Since a path 142 is longer than a path 144, it is in the light which passed along the path 142 slightly to the light which passed along the path 144. The optical path is combined in the interferometer section 146, and the output signal in a terminal 148 will contain the intensity modulation light which superimposed AM subcarrier concession. When a discriminator separates from the absolute value of vibration frequency and operates, in order to prevent the drift of optical subcarrier vibration frequency, it is necessary to have the laser which had a standard reference by the transmitter side.
[0030] The transfer characteristics over the vessel according to light valve of drawing 9 are illustrated to drawing 10 . The transfer characteristics keep linearity considerable in the field which has been illustrated as 152 and in which the vessel according to light valve operates like. this Mach - explanation beyond this of a TSUENDA-interferometer -- "the integration 4 channel Mach-TSUENDA-multi / demultiplexers" which incorporated on Si SiO2 waveguide which doped phosphorus, such as B.H. VERUBI-KU (B. H.Verbeek), and IEEE Lightwave Technology LT-6 and pp. -- it is explained by 1011 and 1988 in full detail. Other optical distribution equipments, for example, FABURI, - A thing like the Perrault interferometer is also usable as a vessel according to light valve.
[0031] The configuration of the laser subsystem 60 of drawing 5 is illustrated to drawing 6 . AM subcarrier block 120 inputs into an RF cycle modulator like the push pull VCO illustrated from the terminal 81 to drawing 2 . Although an optical subcarrier is supplied from laser 84, when you need by FM discriminator by the side of a receiver, in order to maintain laser appearance center-of-force vibration frequency at a fixed point, it forms the standard reference 82 which shows the absolute value of vibration frequency. An optical subcarrier is modulated with RF cycle modulation subcarrier output from a modulator 86 with the optical frequency modulator 88. And an optical subcarrier will transmit AM subcarrier block 120 with an optical frequency modulated wave.
[0032] The external optical frequency modulator 88 changes RF modulated wave from a modulator 86 into an optical field wave. An optical frequency modulator bears the role using acoustooptics or the magneto-optical effect, and the example of this equipment is described by reference. For example, MBB 3-1 and pp.29-31 have described the technique of a magneto-optics interaction convertible into an optical field for the broadband RF cycle modulating signal in C.S. Tsai, "the method light guide beam deflection of **-ed

[broadband] using a static magnetism forward wave and RF analysis of a spectrum" of D. young (C. S.Tsai and D.Young) , Integrated and Guided-wave Optics Topical Meeting, (IGWO) and Houston, Texas, and February six - 8 1989 years.
[0033] Moreover, C.S. Tsai and Z.Y. chain (C. S.Tsai andZ.Y.Cheng) , explain "the frequency shifter by new integration acoustooptics", IGWO, Houston, Texas, February 6 - 8, 1989TuAA 5-1, and the acoustooptic interaction technique used for the same object by pp.142-145.
[0034] Moreover, C.S. Tsai, T.Q. VU -, and J.A. Norris (C. S.Tsai, T.Q.Vu, and J.A.Noris), In-and-out of the light of such a modulator is tied up and discussed by MDD 4-1 and pp.76-79 in ** "formation of the lens array in the planar metal lens by the ion implantation method, and GaAs", IGWO, Houston, Texas, and February six - 8 1989 years. It clarifies also about the lens currently integrated by the modulator.
[0035] In order to actually change FM signal-processing gain, i.e., to make a CN ratio increase to a desired value when adopting the modulator currently explained in full detail by reference (Tsai et al) reference, such as above-mentioned Tsai, it is necessary to carry out broadband FM conversion of the AM subcarrier information first. This conversion is performed in the usual electronic circuitry in RF field.
[0036] The equipment which supplies the optical frequency modulation subcarrier which transmits two or more separate AM subcarrier blocks 120 to drawing 7 is illustrated. AM subcarrier block is inputted into separate RF frequency modulator (only the modulator 108 is illustrated in drawing 7) with a terminal 121. The output of other RF frequency modulators (not shown) holds another subcarrier, and is connected to terminals 95 and 101.
[0037] Each block of AM subcarrier is optically modulated on the separate optical subcarrier supplied by corresponding laser. By having the laser according to individual to the separate block of a subcarrier, the total channel capacity of this lightwave transmission system can be increased. For example, the laser 92 of the 1st optical frequency W1 (it is possible to hold to constant value by the optical frequency absolute value reference 90) outputs the optical subcarrier modulated by optical frequency 94.
[0038] Laser 98 supplies the 2nd output of the vibration frequency W2 which can be maintained at constant value in the vibration frequency absolute value reference 96, when the vessel according to light valve by the side of a receiver needs. This optical subcarrier is modulated with the optical frequency modulator 100. Eventually, laser 104 supplies the optical output of vibration frequency Wn (maintained at constant value in the vibration frequency absolute value reference 102, if required), and is modulated with a modulator 106. Each modulation subcarrier from laser 92 and 98,104 is inputted into a multiplexer 110, and is combined and transmitted to a single lightwave signal.
[0039] The optical multiplexers 110 (and optical demultiplexer by the side of a corresponding receiver) are the components by the known technique. This multiplexer is made of the easiest example from the wavelength insensible fiber coupler. A micro light grid, a die clo IKKU multilayer dielectric filter, or unbalance Mach - All TSUENDA-interferometers etc. are equipped with the function of a multiplexer and a demultiplexer, for example, please refer to FG5 in "the waveguide element with which wavelength division multiplex integration of [on Si substrate] was carried out" of M. KAWACHI (M. Kawachi), Conference on Laser and Electro-optics, Baltimore, Maryland, and 24-April 28 1989 year.
[0040] In the example of drawing 7 , it also has the light amplifier. When an optical frequency modulator has only very small residual amplitude modulation, a semi-conductor light amplifier is used. Erbium fiber-amplifier can be used and amplitude induction crosstalk can be prevented more. It is possible to connect some light amplifiers to a fiber distribution system at a serial, and to be able to perform economization of all expense, and to extend signal transduction distance.
[0041] One approach that I accept it in order for AM subcarrier block to perform the optical frequency modulation of an optical subcarrier to drawing 8 is illustrated. In this example, AM subcarrier block 120 inputs into a terminal 123, and is carrying out direct modulation of the inrush current of semiconductor laser 132. Change of an inrush current generates an optical frequency chirp in laser, and, as a result, the linearity of FM response becomes good.
[0042] For example, I want to refer to "the multi-electrode distribution feedback form laser for pure frequency modulation and tea-ping control amplitude modulation" of Y. YOSHIKUNI and G. MOTOSUGI (Y. Yoshikuni and G.Motosugi), Journal of Lightwave Technology, Vol.LT-5, and No. April, 1987 [4 or].
[0043] Laser 132 is having the absolute value readjusted by the vibration frequency absolute value reference, and this is the need for the optical frequency multiplexer of a system, a demultiplexer, and a discriminator operating with specific optical frequency. Probably, it will be clear that this vibration

frequency absolute value reference's it is better to surely have. For this reason, the photocurrent effectiveness or a gas cell can be used, for example.
[0044] For example, Y.C. Chillan, P.D. Carty (Y. C.Chung, "cold start 1.5micromFSK heterodyne detection experiment" Optical Fiber Communications Conference of P.D.Tkach), Houston, Texas, 6-February 9, 1989, "Frequency discrimination of the packed DFB laser in 1.5-micrometer field and stabilization" of TUI5 and M.W. Maeda, and R.E. Wagner (M. W.Maeda, R.E.Wagner), and Optical Fiber Communications I want to refer to TUI4 in Conference, Houston, Texas, and 6-February 9 1989 year.
[0045] I think that it became clear that this invention is what offers the system which abolishes the disadvantageous point of the conventional AM fiber optics communication, and transmits an amplitude modulation image subcarrier block to an optical transmission path. The linearity of an optical-communication path will not be in the condition like the present system of feeling uneasy, but an AM signal can be transmitted like AM transmission by repeating frequency modulation.
[0046] The linearity in the frequency modulation in an electric field is produced in operating an FM modulator on a microwave frequency. The frequency deviation which can be used by having 2 sets of balanced voltage controlled oscillators as compared with the case where the linearity of a modulation process is increase and single VCO doubles. Lower part changeover of a frequency is performed by combining a VCO output in a double balance mixer.
[0047] without it deviates from the real intention and range of this invention of a claim if it is the people well versed in the technique although this invention has been explained with various examples -- versatility -- extensive -- I think that business and an improvement can be aimed at.
[0048]
[Effect of the Invention] Since this invention transmits an optical subcarrier through an optical-communication path as explained above, it is the block of the usual AM channel signal, and can attain a low CN ratio and a distorted component by carrying out FM modulation of the RF subcarrier. Conventionally, the trouble accompanying multiplexer-channel AM transmission solved the point which was difficult for the CN ratio and distorted component as a requirement of AM transmission to attain in an optical transmission system.
[0049] That is, multiplexer-channel image transmission was conventionally transmitted by each subcarrier of many FM modulation image channels. However, the technique of this FM subcarrier modulation for image distribution will need a demodulator as well as a modulator and a receiving side under exclusive contract by the transmitting side to each channel, respectively, and will require costs. Furthermore, in order to make it compatible with the present cable system, in such FM transmission, frequency conversion must be carried out for suitable channel distribution, and the complicated system which uses many components for this reason will be needed.
[0050] This invention was able to solve many of these problems by offering the approach and equipment accompanied by the advantage of the low CN ratio which is the requirement of FM transmission, and a distorted component, reconciling the advantage of AM signal distribution.

[Translation done.]

EFFECT OF THE INVENTION

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[Translation done.]

EXAMPLE

[Example] In order that this invention may transmit an optical subcarrier through an optical-communication path, it is the block of the usual AM channel signal, and the advantage which can attain a low CN ratio and a distorted component is born by carrying out FM modulation of the RF subcarrier. If an optical subcarrier is equipped with the linearity of the moderate laser circuit for FM transmission, and the conditions of a CN ratio, and is supplied from laser, for example, about 18dB of CN ratios becomes, it will be enough for FM transmission, and will only be needing the 2nd and about 20dB of the 3rd compound distorted components. This is completely advantageous as compared with the about 40dB CN ratio needed for AM transmission.
[0016] Although this invention is related to fiber-optic cable television systems and explained, if it is the people well versed in the technique, it will be able to admit that this invention is applicable to other optical-communication networks.
[0017] The example of the beginning of invention is illustrated from drawing 1 to drawing 4 . From about 50 to about 550MHz, the channel signal of each [6MHz frequency allocation] is included in the present AM cable television band 10 so that clearly [in drawing 1], and it can expect that bandwidth is extended up to about 1 GHZ in the future. The present frequency band 10 is inputted into the block converter 14 from a terminal 12.
[0018] In this invention, the broadband VCO to the frequency (for example, 2.2GHz) for modulating RF subcarrier with AM cable band is included in the block converter 14. As for the frequency modulation by AM cable band, it is advantageous that the band of the range of microwave performs, and the bandwidth of a block of a television subcarrier is [in this case / the actuation frequency of a voltage controlled oscillator] small.
[0019] After the filter of the FM modulation subcarrier is carried out with a low pass filter 18, it carries out direct modulation of the laser 22. The limit by the requirement and optical-fiber circuit of communication system is followed, and it is FABURI. - The laser of common knowledge structure like the Perrault form, a distribution feedback form (DFB), or quantum Igata is used. Of course, external modulation or other intensity modulation can be used for the modulation of this lightwave signal.
[0020] the example of drawing 1 -- FABURI - the Perrault rhe -- the -- intensity modulation of -22 is carried out by RF subcarrier containing a band 20. Consequently, the optical subcarrier including the block of a television channel signal by which intensity modulation was carried out is generated, and it is transmitted to the optical Ferber receiver 26 through the optical Ferber network 24. So, the optical subcarrier output from laser 22 contains AM cable band of the origin by which FM modulation was carried out in the high frequency field, and will transmit an intensity modulation signal through an optical-communication way. such -- dividing -- coming out -- an intensity modulation signal -- optical-AM/RF-FM/RF- an AM signal -- or if it says simply, it can be regarded as AM/FM/AM signal.
[0021] The optical-fiber receiver 26 is common equipment for receiving an optical subcarrier and taking out the information (in this case, it being RF subcarrier (FM/AM) including the block of AM channel signal by which FM modulation was carried out) by which intensity modulation was carried out. The taken-out information is inputted into the block demodulator of 28, is changed into a higher frequency on the local oscillation frequency applied from a terminal 32 by the mixer 30, and takes out the original AM band by the broadband discriminator 34. Upper part conversion of FM / AM signal frequency is advantageous especially when a tuning circuit discriminator is used for the ejection of AM band. Taken-out AM cable band 10 is outputted from a block demodulator.

[0022] The block diagram of drawing 2 has illustrated one of the examples of a broadband VCO 16. It is operated with the center frequency which is about 21GHz which can be satisfied with this example of the linearity of the AM signal block inputted with the terminal 12 in order to modulate the subcarrier by which connected with push PURUMO-DO and the voltage controlled oscillators (VCO) 40 and 42 of a couple were made from VCO. It is clear 500MHz bandwidth's of the AM band 10 to fit in the VCO clock frequency of about 21GHz easily.
[0023] It is combined with the double balance mixer 44, and the output of VCO40 and VCO42 transforms the frequency of an FM modulation RF subcarrier caudad so that both optical transmitter in the existing communication system and receiver can be shared. This RF subcarrier is used for the direct modulation of laser 22. FM modulation subcarrier output outputted with the microwave carrier frequency of 21GHz from VCO 40 and 42 is heterodyne-ized by the mixer 44, and makes the signal band 20 whose center frequency which was illustrated to drawing 1 is about 2.2GHz. A high frequency component is removed from the cycle taking-out force of Broadband VCO with a low pass filter 18.
[0024] The straight-line relation 50 between the input voltage in the output of the double balance mixer 44 and an output frequency is illustrated to drawing 3 . Moreover, the ideal transfer characteristics of the result of having performed push PURUMO-DO of VCO 40 and 42 to drawing 4 are illustrated. Similarly the line 54 expresses the deviation to a lower part for the deviation to the upper part of a main cycle [as opposed to change of input voltage in a line 52] again.
[0025] At a receiver side, an amplitude modulation channel signal block is taken out by the broadband FM discriminator 34 (drawing 1). This discriminator is the thing of the type of common knowledge like an easy low pass filter which identifies that transition state, can use the double balance VCO of the structure same on the other hand again as a broadband VCO 16 for FM discrimination by the side of a receiver, and also it may use the RF FM discriminator of other common knowledge.
[0026] Another example by this invention is illustrated from drawing 5 to drawing 10 . In this example, AM subcarrier (for example, image) block information is distributed to the optical fiber using an optical frequency modulation. In the arrangement shown in drawing 5 , the laser subsystem supplies the optical subcarrier. The optical frequency modulation of the subcarrier output from the laser subsystem 60 is carried out with AM subcarrier block 120 inputted with a terminal 63.
[0027] The optical subcarrier by which the vibration frequency modulation was carried out is amplified with a light amplifier 62, and is inputted into a splitter 64, and this output is connected to fiber-optic cable television transmission Aminaka's separate transmitting path [each]. In the path shown in drawing 5 , the subcarrier by which FM modulation was carried out optically reaches the vessel 68 according to light valve through the fiber circuit 66, and takes out AM subcarrier from an optical subcarrier.
[0028] it is possible to utilize the technique of the vessel according to light valve of common knowledge like an optical delay circuit, a light filter, an unbalance RF interferometer, a wave division multiplex grid, and (or) a dielectric film as a vessel according to this light valve. The output of the vessel 68 according to light valve is detected by the usual photodetector 70, and is changed into an electric field. The acquired electrical signal is amplified with the RF amplifier 72, and it restores to it to each AM subcarrier by the usual approach.
[0029] Mach illustrated to drawing 9 as an example of the vessel according to light valve used for the example of drawing 5 - A TSUENDA-interferometer type light vibration frequency discriminator is raised. An optical vibration frequency modulation light from the fiber circuit 66 inputs with a terminal 140, and is divided into two paths 142 and 144 of inequality length. Since a path 142 is longer than a path 144, it is in the light which passed along the path 142 slightly to the light which passed along the path 144. The optical path is combined in the interferometer section 146, and the output signal in a terminal 148 will contain the intensity modulation light which superimposed AM subcarrier concession. When a discriminator separates from the absolute value of vibration frequency and operates, in order to prevent the drift of optical subcarrier vibration frequency, it is necessary to have the laser which had a standard reference by the transmitter side.
[0030] The transfer characteristics over the vessel according to light valve of drawing 9 are illustrated to drawing 10 . The transfer characteristics keep linearity considerable in the field which has been illustrated as 152 and in which the vessel according to light valve operates like. this Mach - explanation beyond this of a TSUENDA-interferometer -- "the integration 4 channel Mach-TSUENDA-multi / demultiplexers" which incorporated on Si SiO2 waveguide which doped phosphorus, such as B.H. VERUBI-KU (B.

H.Verbeek), and IEEE Lightwave Technology LT-6 and pp. -- it is explained by 1011 and 1988 in full detail. Other optical distribution equipments, for example, FABURI, - A thing like the Perrault interferometer is also usable as a vessel according to light valve.

[0031] The configuration of the laser subsystem 60 of drawing 5 is illustrated to drawing 6 . AM subcarrier block 120 inputs into an RF cycle modulator like the push pull VCO illustrated from the terminal 81 to drawing 2 . Although an optical subcarrier is supplied from laser 84, when you need by FM discriminator by the side of a receiver, in order to maintain laser appearance center-of-force vibration frequency at a fixed point, it forms the standard reference 82 which shows the absolute value of vibration frequency. An optical subcarrier is modulated with RF cycle modulation subcarrier output from a modulator 86 with the optical frequency modulator 88. And an optical subcarrier will transmit AM subcarrier block 120 with an optical frequency modulated wave.

[0032] The external optical frequency modulator 88 changes RF modulated wave from a modulator 86 into an optical field wave. An optical frequency modulator bears the role using acoustooptics or the magneto-optical effect, and the example of this equipment is described by reference. For example, MBB 3-1 and pp.29-31 have described the technique of a magneto-optics interaction convertible into an optical field for the broadband RF cycle modulating signal in C.S. Tsai, "the method light guide beam deflection of **-ed [broadband] using a static magnetism forward wave and RF analysis of a spectrum" of D. young (C. S.Tsai and D.Young) , Integrated and Guided-wave Optics Topical Meeting, (IGWO) and Houston, Texas, and February six - 8 1989 years.

[0033] Moreover, C.S. Tsai and Z.Y. chain (C. S.Tsai andZ.Y.Cheng) , explain "the frequency shifter by new integration acoustooptics", IGWO, Houston, Texas, February 6 - 8, 1989TuAA 5-1, and the acoustooptic interaction technique used for the same object by pp.142-145.

[0034] Moreover, C.S. Tsai, T.Q. VU -, and J.A. Norris (C. S.Tsai, T.Q.Vu, and J.A.Noris), In-and-out of the light of such a modulator is tied up and discussed by MDD 4-1 and pp.76-79 in ** "formation of the lens array in the planar metal lens by the ion implantation method, and GaAs", IGWO, Houston, Texas, and February six - 8 1989 years. It clarifies also about the lens currently integrated by the modulator.

[0035] In order to actually change FM signal-processing gain, i.e., to make a CN ratio increase to a desired value when adopting the modulator currently explained in full detail by reference (Tsai et al) reference, such as above-mentioned Tsai, it is necessary to carry out broadband FM conversion of the AM subcarrier information first. This conversion is performed in the usual electronic circuitry in RF field.

[0036] The equipment which supplies the optical frequency modulation subcarrier which transmits two or more separate AM subcarrier blocks 120 to drawing 7 is illustrated. AM subcarrier block is inputted into separate RF frequency modulator (only the modulator 108 is illustrated in drawing 7) with a terminal 121. The output of other RF frequency modulators (not shown) holds another subcarrier, and is connected to terminals 95 and 101.

[0037] Each block of AM subcarrier is optically modulated on the separate optical subcarrier supplied by corresponding laser. By having the laser according to individual to the separate block of a subcarrier, the total channel capacity of this lightwave transmission system can be increased. For example, the laser 92 of the 1st optical frequency W1 (it is possible to hold to constant value by the optical frequency absolute value reference 90) outputs the optical subcarrier modulated by optical frequency 94.

[0038] Laser 98 supplies the 2nd output of the vibration frequency W2 which can be maintained at constant value in the vibration frequency absolute value reference 96, when the vessel according to light valve by the side of a receiver needs. This optical subcarrier is modulated with the optical frequency modulator 100. Eventually, laser 104 supplies the optical output of vibration frequency Wn (maintained at constant value in the vibration frequency absolute value reference 102, if required), and is modulated with a modulator 106. Each modulation subcarrier from laser 92 and 98,104 is inputted into a multiplexer 110, and is combined and transmitted to a single lightwave signal.

[0039] The optical multiplexers 110 (and optical demultiplexer by the side of a corresponding receiver) are the components by the known technique. This multiplexer is made of the easiest example from the wavelength insensible fiber coupler. A micro light grid, a die clo IKKU multilayer dielectric filter, or unbalance Mach - All TSUENDA-interferometers etc. are equipped with the function of a multiplexer and a demultiplexer, for example, please refer to FG5 in "the waveguide element with which wavelength division multiplex integration of [on Si substrate] was carried out" of M. KAWACHI (M. Kawachi), Conference on Laser and Electro-optics, Baltimore, Maryland, and 24-April 28 1989 year.

[0040] In the example of drawing 7 , it also has the light amplifier. When an optical frequency modulator has only very small residual amplitude modulation, a semi-conductor light amplifier is used. Erbium fiber-amplifier can be used and amplitude induction crosstalk can be prevented more. It is possible to connect some light amplifiers to a fiber distribution system at a serial, and to be able to perform economization of all expense, and to extend signal transduction distance.
[0041] One approach that I accept it in order for AM subcarrier block to perform the optical frequency modulation of an optical subcarrier to drawing 8 is illustrated. In this example, AM subcarrier block 120 inputs into a terminal 123, and is carrying out direct modulation of the inrush current of semiconductor laser 132. Change of an inrush current generates an optical frequency chirp in laser, and, as a result, the linearity of FM response becomes good.
[0042] For example, I want to refer to "the multi-electrode distribution feedback form laser for pure frequency modulation and tea-ping control amplitude modulation" of Y. YOSHIKUNI and G. MOTOSUGI (Y. Yoshikuni and G.Motosugi), Journal of Lightwave Technology, Vol.LT-5, and No. April, 1987 [4 or].
[0043] Laser 132 is having the absolute value readjusted by the vibration frequency absolute value reference, and this is the need for the optical frequency multiplexer of a system, a demultiplexer, and a discriminator operating with specific optical frequency. Probably, it will be clear that this vibration frequency absolute value reference's it is better to surely have. For this reason, the photocurrent effectiveness or a gas cell can be used, for example.
[0044] For example, Y.C. Chillan, P.D. Carty (Y. C.Chung, "cold start 1.5micromFSK heterodyne detection experiment" Optical Fiber Communications Conference of P.D.Tkach), Houston, Texas, 6-February 9, 1989, "Frequency discrimination of the packed DFB laser in 1.5-micrometer field and stabilization" of TUI5 and M.W. Maeda, and R.E. Wagner (M. W.Maeda, R.E.Wagner), and Optical Fiber Communications I want to refer to TUI4 in Conference, Houston, Texas, and 6-February 9 1989 year.
[0045] I think that it became clear that this invention is what offers the system which abolishes the disadvantageous point of the conventional AM fiber optics communication, and transmits an amplitude modulation image subcarrier block to an optical transmission path. The linearity of an optical-communication path will not be in the condition like the present system of feeling uneasy, but an AM signal can be transmitted like AM transmission by repeating frequency modulation.
[0046] The linearity in the frequency modulation in an electric field is produced in operating an FM modulator on a microwave frequency. The frequency deviation which can be used by having 2 sets of balanced voltage controlled oscillators as compared with the case where the linearity of a modulation process is increase and single VCO doubles. Lower part changeover of a frequency is performed by combining a VCO output in a double balance mixer.
[0047] without it deviates from the real intention and range of this invention of a claim if it is the people well versed in the technique although this invention has been explained with various examples -- versatility -- extensive -- I think that business and an improvement can be aimed at.

[Translation done.]

* NOTICES *

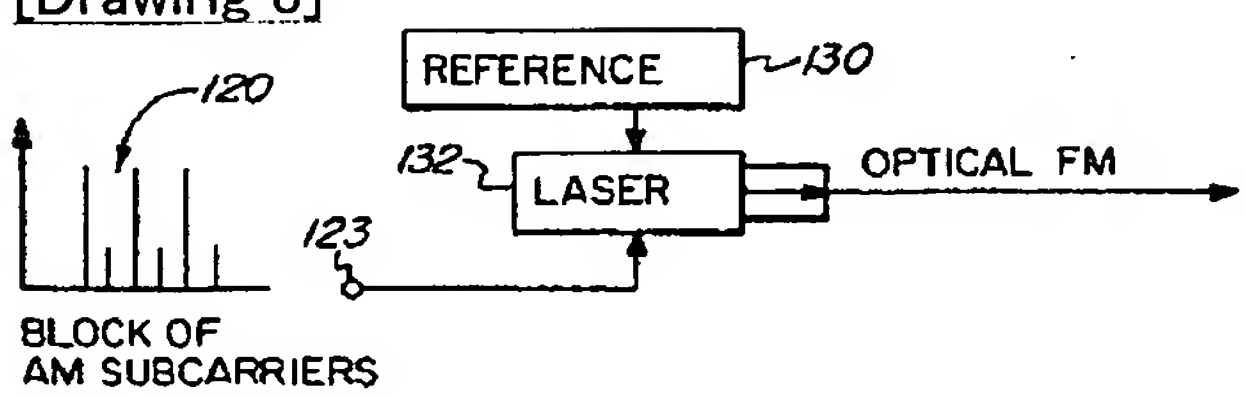
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is a block diagram illustrating the system of this invention.
[Drawing 2] It is a block diagram illustrating the example of the broadband VOC currently used by the block converter of drawing 1 .
[Drawing 3] It is the graph having shown the linearity of actuation of the broadband VOC of drawing 2 .
[Drawing 4] It is the ideal transfer function of the broadband VOC of drawing 2 .
[Drawing 5] The optical frequency of an optical subcarrier is the block diagram of another example of this invention modulated with the block of AM subcarrier.
[Drawing 6] It is a block diagram illustrating how the block of AM subcarrier performs an external optical frequency modulation for an optical subcarrier.
[Drawing 7] It is a block diagram illustrating the approach of performing an external optical frequency modulation for two or more optical subcarriers by the block with which AM subcarriers differ.
[Drawing 8] It is the block diagram which illustrated the direct optical frequency becoming [irregular] method of an optical subcarrier with the block of AM subcarrier.
[Drawing 9] It is the schematic diagram of the unbalance interferometer which can be used as an optical discriminator in the example of drawing 5 .
[Drawing 10] It is the graph of the transfer characteristics illustrating the range which shows the linearity of actuation of the interferometer of drawing 9 .

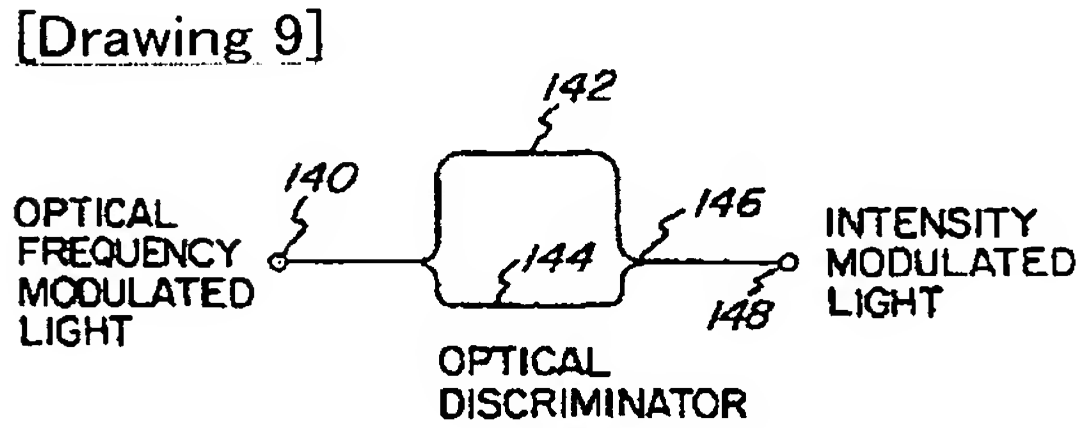
[Translation done.]

DRAWINGS

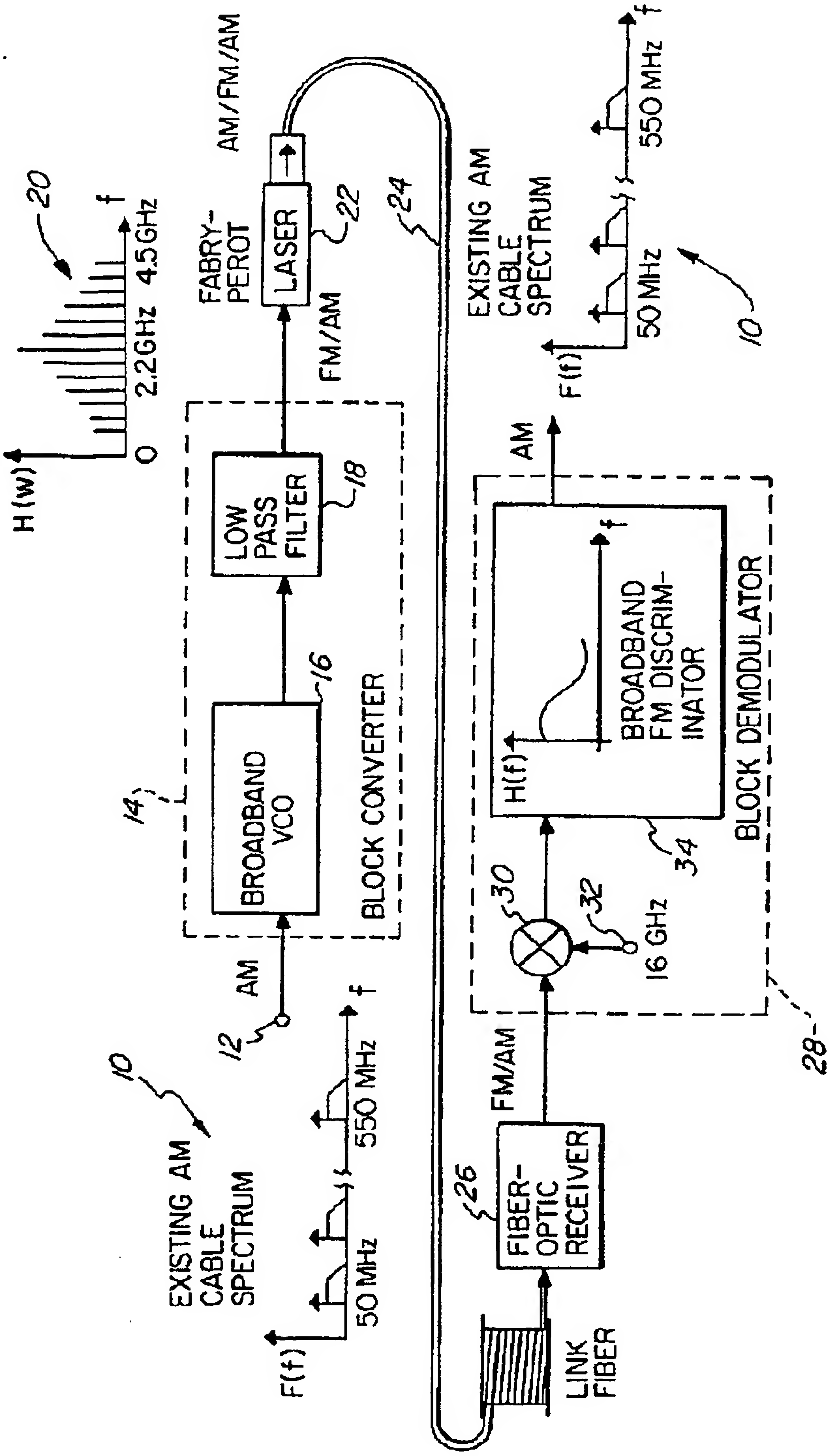
[Drawing 8]



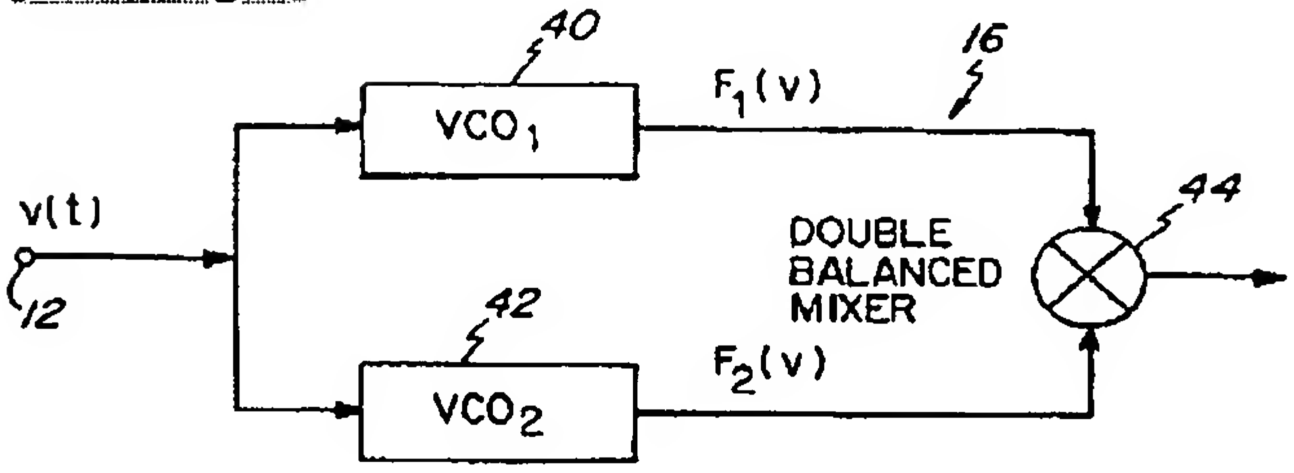
[Drawing 9]



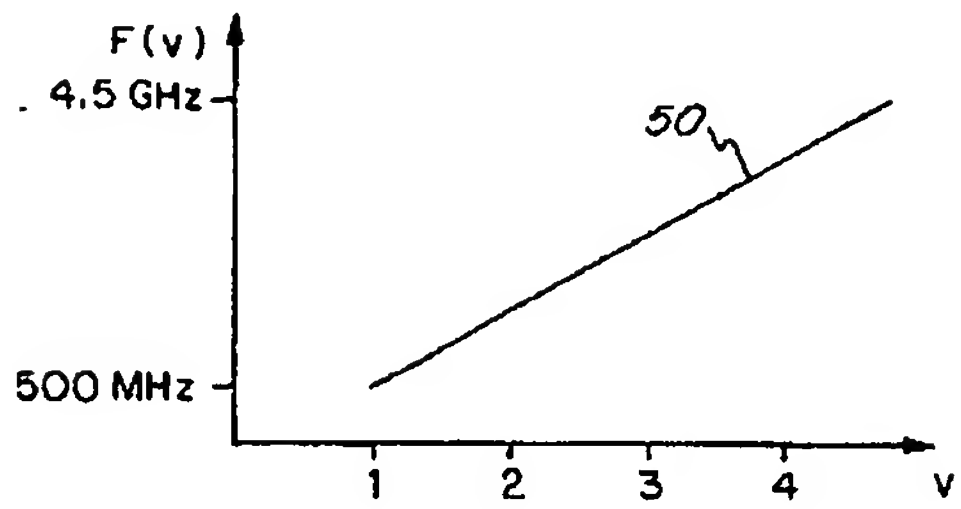
[Drawing 1]



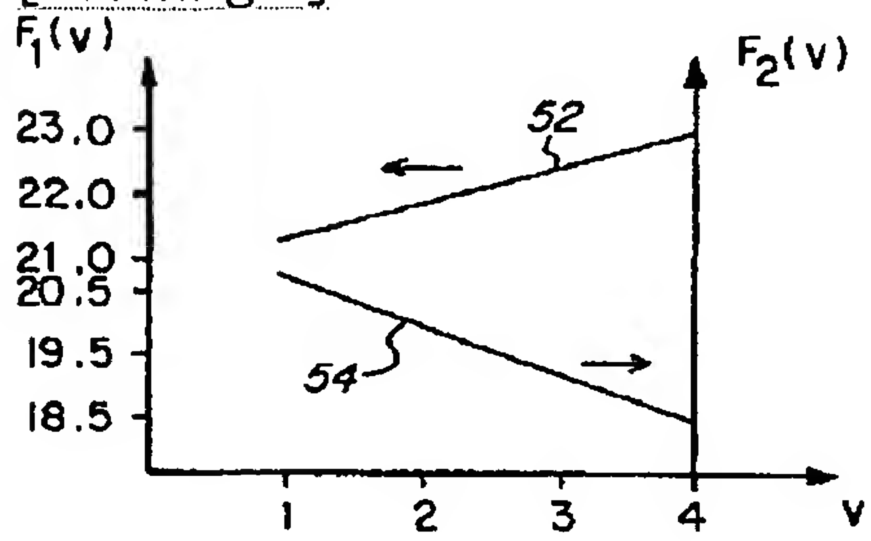
[Drawing 2]



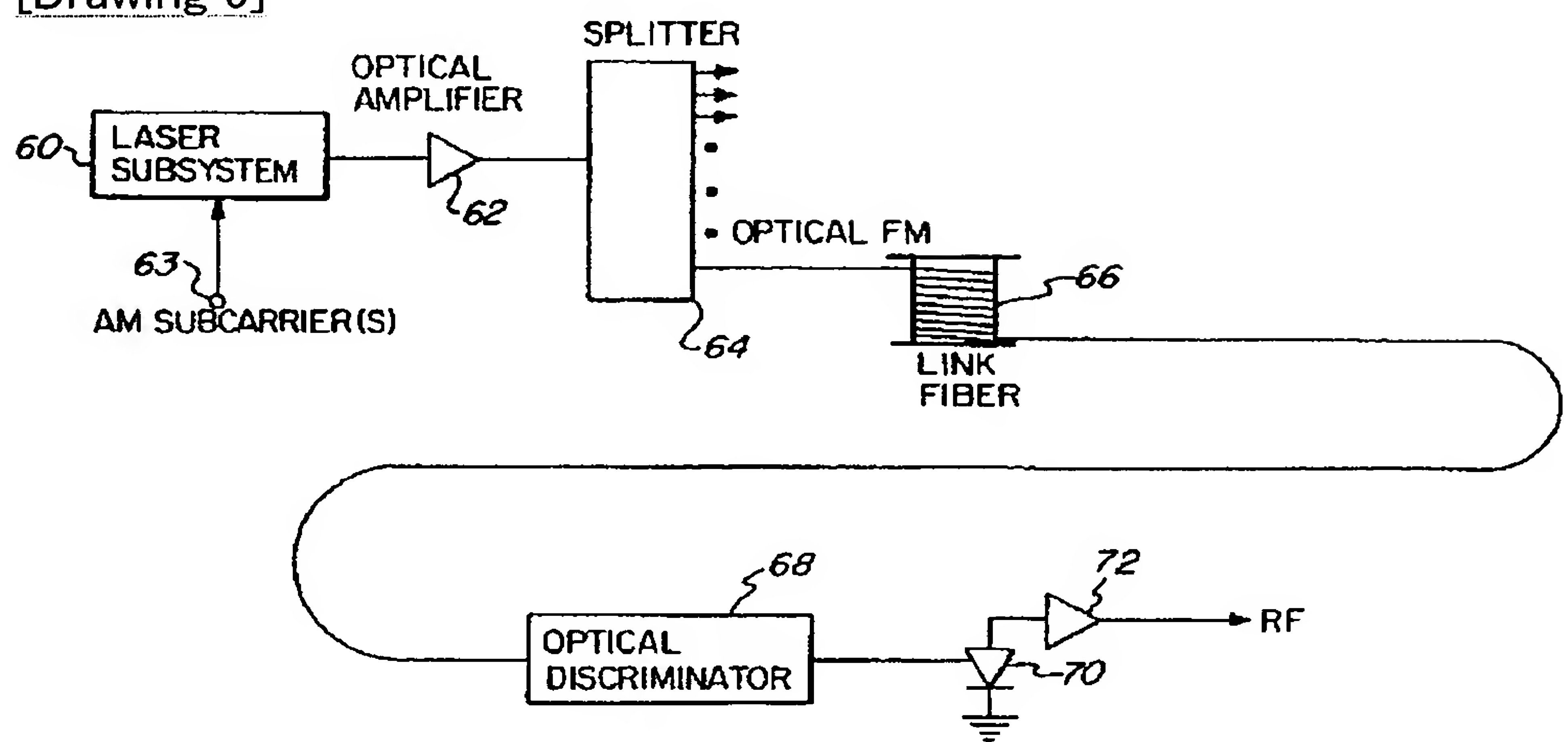
[Drawing 3]



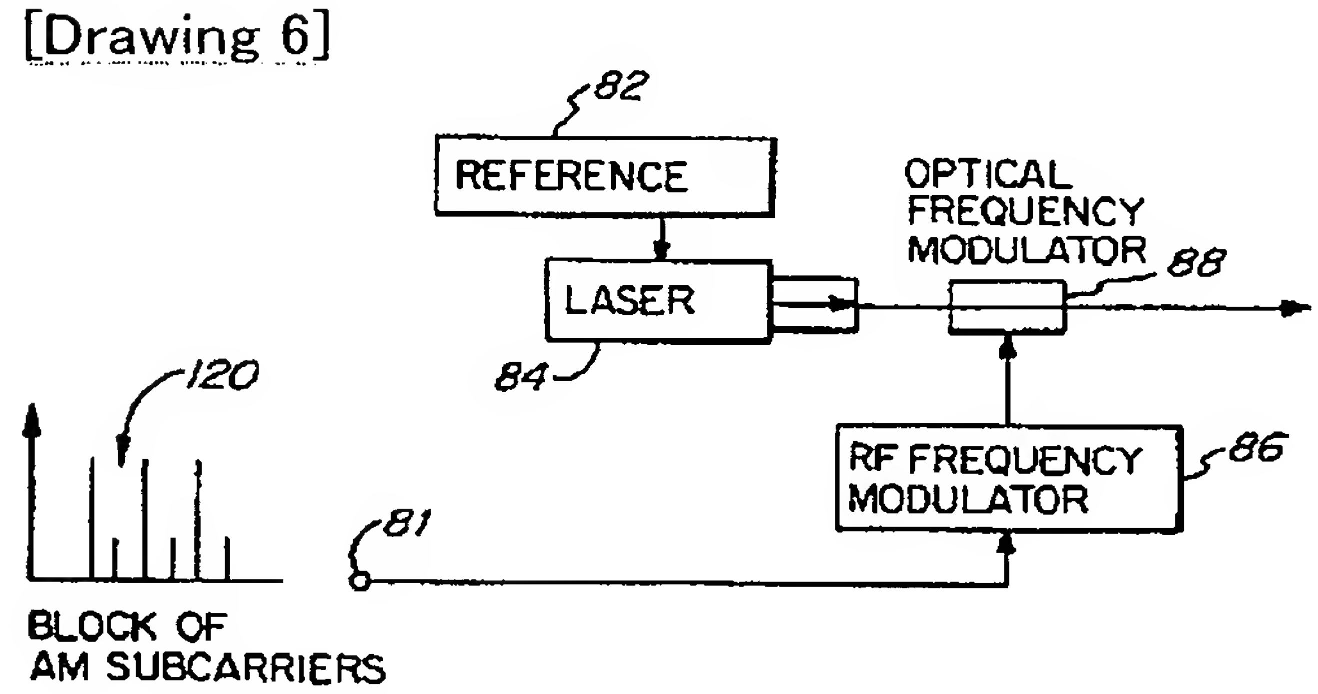
[Drawing 4]



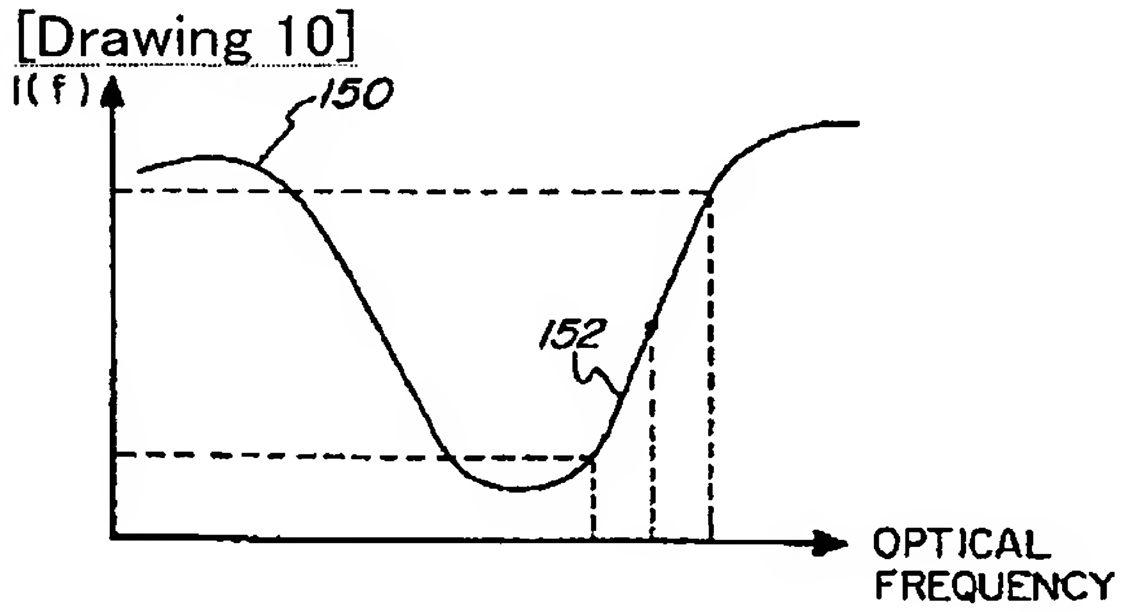
[Drawing 5]



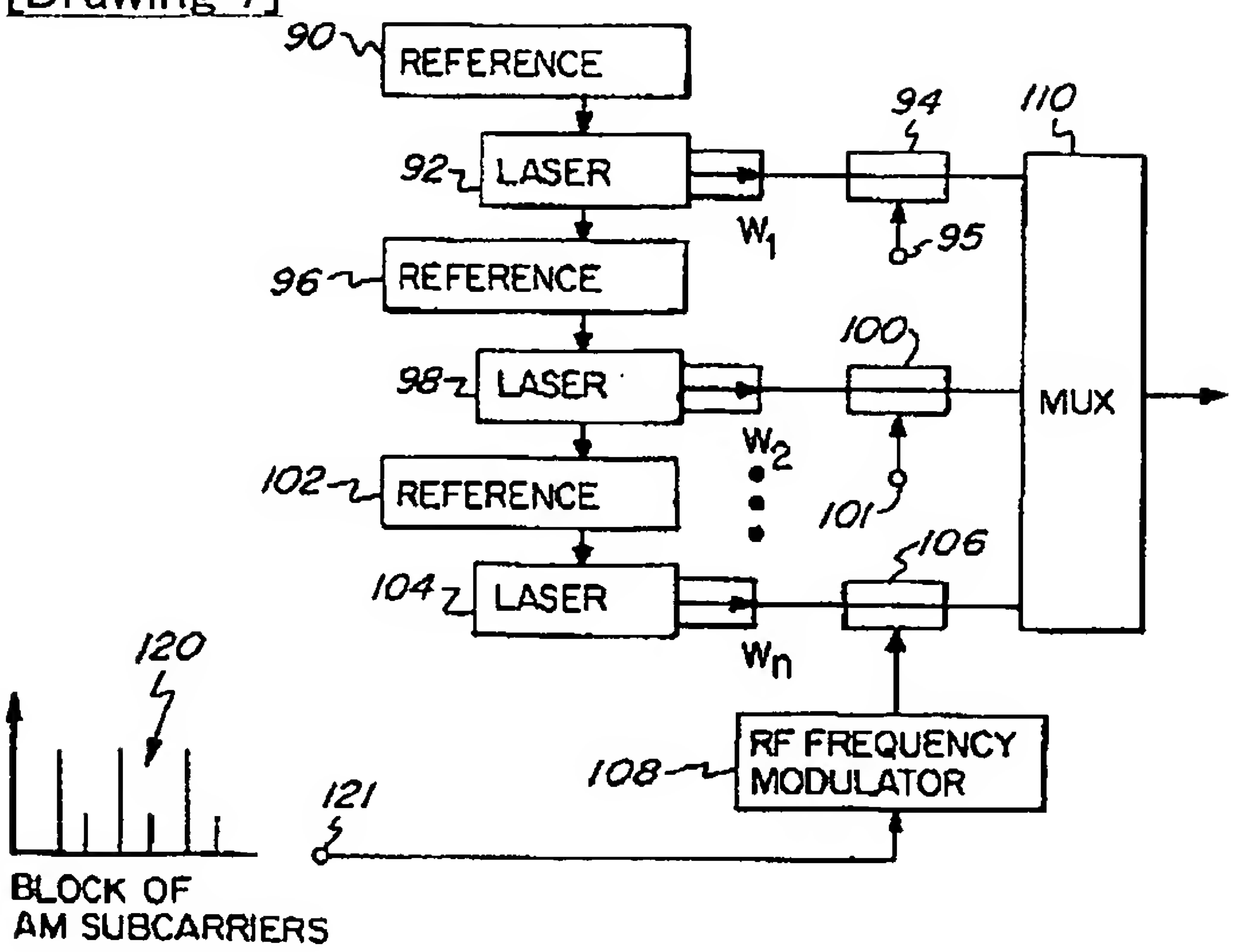
[Drawing 6]



[Drawing 10]



[Drawing 7]



[Translation done.]

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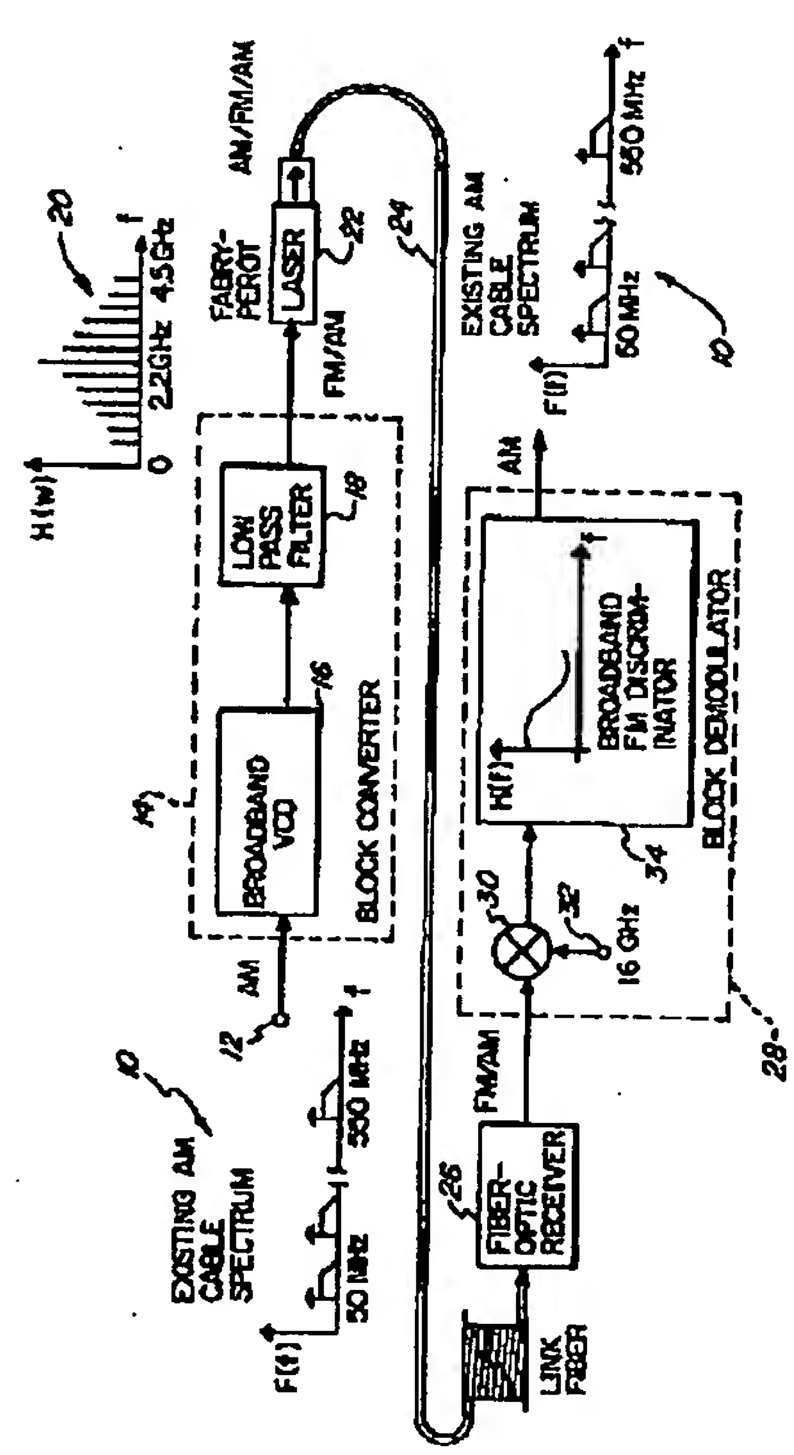
最終頁に続く

(54)【発明の名称】　光通信経路へ振幅変調信号を伝送する方法とその装置

(57)【要約】

【目的】　光通信経路において、ＡＭ信号分配の利点を両立させながら、ＦＭ送信の必要条件である低ＣＮ比と歪成分の利点を達成して、多重チャンネル映像送信を容易にする。

【構成】　振幅変調されたテレビジョン信号ブロックが光通信回路で周波数変調される。ＡＭ変調チャンネル信号がＲＦ副搬送波をＦＭ変調し、これが今度は送信のための光搬送波を輝度変調するのに使われる。振幅変調されたチャンネル信号によるＲＦ副搬送波の周波数変調はマイクロ波周波数で行った方が有利である。ＦＭ変調された副搬送波信号はシステムで使用している送信機及び受信機を共用できる周波数範囲に下方へ変換される。この周波数変調と変換はプッシュプルモードで動作する一対の電圧制御発振器で行われ、この出力はＦＭ信号周波帯を下方に変換させるため２重平衡混合器に接続されている。



【特許請求の範囲】

【請求項１】　光通信経路を経て通信信号を伝送するための方法で、
搬送波を供給し、
振幅変調されたチャンネル信号ブロックで搬送波を周波数変調し、
このＦＭ変調搬送波を光通信経路に伝送する工程からなることを特徴とする方法。

【請求項２】　特許請求項１において、前記ＦＭ変調搬送波を、前記通信経路を経て伝送するための光搬送波を輝度変調するのに使用されるＲＦ副搬送波であることを特徴とする方法。

【請求項３】　特許請求項２において更に、前記ＦＭ変調ＲＦ副搬送波を前記光搬送波の変調のために適当する周波数範囲に変換する工程を含むことを特徴とする方法。

【請求項４】　特許請求項３において更に、前記光通信経路から輝度変調された光搬送波を受信し、
受信した光搬送波から前記周波数変調ＲＦ副搬送波を取り出し、
取り出した周波数変調されたＲＦ副搬送波を復調するために、適当する周波数範囲に変換し、
前記の振幅変調されたチャンネル信号ブロックを取り出すため、ＲＦ副搬送波をＦＭ復調する工程を含むことを特徴とする方法。

【請求項５】　特許請求項１から３において更に、前記の光通信経路から変調された光搬送波を受信し、
受信した光搬送波から前記の周波数変調されたＲＦ副搬送波を取り出し、
前記の振幅変調されたチャンネル信号ブロックを取り出すため、ＲＦ副搬送波をＦＭ復調する工程を含むことを特徴とする方法。

【請求項６】　特許請求項１において、前記のＦＭ変調搬送波は前記の変調工程間に光学振動数変調波を含む光搬送波であることを特徴とする方法。

【請求項７】　特許請求項６において、前記の光搬送波は前記ＡＭチャンネル信号ブロックで直接変調されることを特徴とする方法。

【請求項８】　特許請求項６において、前記の光搬送波は前記の振幅変調されたチャンネル信号ブロックを運ぶ周波数変調ＲＦ副搬送波により変調されることを特徴とする方法。

【請求項９】　光通信経路を通じて通信信号を伝送するための装置で、
振幅変調されたチャンネル信号ブロックで搬送波を周波数変調するための手段と、
光通信経路を通じて周波数変調搬送波を伝送するための手段を含むことを特徴とする装置。

【請求項１０】　特許請求項９において、前記ＦＭ変調搬送波はＲＦ副搬送波で、前記伝送手段は、前記の通信経路を通じて伝送するため、ＦＭ変調されたＲＦ副搬送波で光搬送波を輝度変調するための手段を含むことを特徴とする装置。

【請求項１１】　特許請求項１０において更に、前記のＦＭ変調されたＲＦ副搬送波を前記光搬送波の輝度変調のため適当する周波数範囲に変換するための手段を含むことを特徴とする装置。

【請求項１２】　特許請求項１１において、前記周波数変調と変換の手段は、
プッシュプル動作モードに接続された一対の電圧制御発振器と、
この一対の発振器に前記の振幅変調されたチャンネル信号ブロックを入力するための手段と、
前記の変換されたＲＦ副搬送波を供給するため発振器の出力に接続された２重平衡混合器の手段を含むことを特徴とする装置。

【請求項１３】　特許請求項１２において、前記の電圧制御発振器はマイクロ波周波数範囲で動作することを特徴とする装置。

【請求項１４】　特許請求項９において、前記搬送波は光搬送波で、また前記変調手段はＡＭチャンネル信号ブロックで搬送波の光学振動数を直接変調することを特徴とする装置。

【請求項１５】　特許請求項１４において、前記の周波数変調手段は別々の振幅変調されたチャンネル信号ブロックで複数の別々の搬送波の各々を変調し、また前記装置は更に、
前記の光通信経路を通じて伝送するため前記複数の変調搬送波を結合するための手段を含むことを特徴とする装置。

【請求項１６】　特許請求項９において、前記ＦＭ変調搬送波はＲＦ副搬送波で、また前記伝送手段には前記通信経路を通じて伝送するためＦＭ変調ＲＦ副搬送波で光搬送波を周波数変調するための手段が含まれることを特徴とする装置。

【請求項１７】　特許請求項１６において、複数の別々の光搬送波の各々は、別々の振幅変調されたチャンネル信号ブロックを重畳している別々のＦＭ変調ＲＦ副搬送波で周波数変調され、また前記装置は更に、
前記光通信経路を通じて伝送するため、前記の複数の周波数変調光搬送波を結合するための手段を含むことを特徴とする装置。

【請求項１８】　光搬送波から振幅変調されたチャンネル信号ブロックを取り出すための受信機の装置で、
振幅変調チャンネル信号ブロックで変調された周波数変調ＲＦ副搬送波を収容している輝度変調された光搬送波を光通信経路から受信するための手段と、
光搬送波から周波数変調ＲＦ副搬送波を取り出すための手段と、
振幅変調チャンネル信号ブロックを取り出すため取り出

したＲＦ副搬送波をＦＭ復調するための手段からなることを特徴とする装置。

【請求項19】　特許請求項18において更に、取り出した周波数変調ＲＦ副搬送波を復調のため適当する周波数範囲に変換するため、前記の取り出しの手段と前記ＦＭ復調手段間に接続された手段を含むことを特徴とする装置。

【請求項20】　光通信経路を通じて通信信号を伝送するための方法で、
光搬送波を発生させ、
この光搬送波の光学振動数をＡＭ副搬送波ブロックで光学振動数変調された通信信号を発生させるために変調し、
光通信経路を通じて光学振動数変調通信信号を伝送する工程からなることを特徴とする方法。

【請求項21】　特許請求項20において更に、前記光通信経路から光学振動数変調搬送波を受信し、
受信した光搬送波からＡＭ副搬送波ブロックを取り出す工程を含むことを特徴とする方法。

【請求項22】　光学振動数変調搬送波から振幅変調チャンネル信号ブロックを取り出すための受信機の装置で、
振幅変調チャンネル信号ブロックで周波数変調された光搬送波を受信するための手段と、
受信した光搬送波から振幅変調チャンネル信号ブロックを取り出し、前記ＡＭチャンネル信号ブロックにより輝度変調された光信号を出力させるための光学ＦＭ弁別器からなることを特徴とする装置。

【請求項23】　特許請求項22において更に、前記の輝度変調光信号を前記ＡＭチャンネル信号ブロックを含むＲＦ副搬送波に変換するための手段を含むことを特徴とする装置。

【請求項24】　特許請求項22において、前記ＦＭ弁別器は、ＦＭチャンネル信号ブロックにより変調され、また前記ＲＦ副搬送波により前記の光信号を輝度変調した中の振幅変調チャンネル信号ブロックを取り出すことを特徴とする装置。

【発明の詳細な説明】

【0001】

【発明の背景】本発明は光通信経路を通じて振幅変調（ＡＭ）信号、特に光ファイバー回線網に振幅変調されたケーブルテレビジョン帯信号の送信に関するものである。

【0002】近年アナログ光通信システムの発達が大いに世の関心を集めており、デジタルシステムと比較してアナログ通信システムは帯域幅を効率よく活用できる利点がある。このことは光ファイバーに大量の映像チャンネルを送信する必要のあるケーブルテレビジョン（ＣＡＴＶ）通信システムにとって特に有利に働くことになる。また同軸ケーブル信号伝送で使用されているのと同じ振幅変調残留側波帯（ＡＭ－ＶＳＢ）信号フォーマットを使用することで現行の装置をそのまま共用できることになる。

【0003】ＡＭ－ＶＳＢ映像副搬送波からなるテレビジョン信号を採用すると、ＮＴＳＣテレビジョン規準とフォーマットが両立でき、また許可された帯域幅内にチャンネル数を増やすことができ、望ましいことと思われる。しかし、ＡＭ－ＶＳＢ送信の欠点の一つに、映像信号の周波数変調またはデジタル送信の様な他の手法に比べて搬送波対雑音比（ＣＮ比）をより高レベルに要求されることである。通常ＡＭ－ＶＳＢテレビジョン信号を明瞭に受信するためには少なくとも40ｄＢのＣＮ比が必要である。

【0004】光ファイバーを通じて情報信号（例えばテレビジョン信号）を送信するためには、その情報信号で光ビーム（搬送波）を変調しなければならない。光源からのレーザーの直接変調またはレーザービームの外部変調等、周知の方法に対する種種のアプローチがなされたが、各々には利点および欠点があり、また現時点の技術では多重チャンネルの振幅変調副搬送波映像の送信に対して十分な直線性とダイナミックレンジを示す半導体レーザーを入手することは難しいと思われる。

【0005】多重チャンネルＣＡＴＶシステムは市場競争で残るために40又はそれ以上のチャンネル数を供給しなければならない。この多重チャンネルＡＭ送信に伴う問題点はＡＭ伝送の必要条件としてのＣＮ比と歪成分が光通信システムにおいては達成することが難しいということである。

【0006】周波数変調（ＦＭ）では必要条件としてのＣＮ比と歪成分がもっと低くてもよいのである。当初多重チャンネル映像送信は多数のＦＭ変調映像チャンネルの各各の副搬送波により送信されていた。しかし、映像分配に対するこのＦＭ副搬送波変調の手法は、各チャンネルに対し送信側でそれぞれ専属の変調器と受信側に同じく復調器を必要とし費用がかかることになる。更に現行ケーブルシステムと両立させるため、この様なＦＭ送信では適当なチャンネル分配のため周波数変換をしなければならず、このため多数の部品を使用する複雑なシステムを必要とすることになる。

【0007】ＡＭ信号分配の利点を両立させながら、ＦＭ送信の必要条件である低ＣＮ比と歪成分の利点を伴う方法と装置を提供することは有益なことであろう。この様な方法を使って送信された信号を受信するための受信機を提供できれば更に有益なことであろう。本発明はこの様な方法と装置を提供するものである。

【0008】

【発明の概要】本発明は光通信経路へ通信信号を伝送する方法を提供するものである。通常の振幅変調（ＡＭ）チャンネル信号ブロックはＲＦ副搬送波を周波数変調するのに使われている。そして光搬送波が周波数変調副搬

送波で変調され、光ファイバーの様な光通信経路に伝送されるのである。第１の実施例ではＡＭ信号ブロックを含む周波数変調副搬送波で光搬送波を変調する輝度変調が使われている。

【０００９】信号処理を容易にするため、周波数変調されたＲＦ副搬送波は光搬送波の変調のための適当する周波数範囲に変換される。例えば振幅変調チャンネル信号帯によるＲＦ副搬送波の周波数変調をマイクロ波周波数範囲で行った後、光送信機及び光受信機の様な光通信システム機器を共用できる低い周波数範囲にこの副搬送波を変換する。

【００１０】この第１実施例で使われる受信機は光通信経路から輝度変調された光搬送波を受信し、この搬送波から周波数変調されたＲＦ搬送波を取り出し、ＡＭチャンネル信号ブロックを復旧する復調のため必要ならば適当する周波数範囲に変換する。取り出した信号ブロックはそれからテレビジョン受信機またはその他の送信機器に入力し、選んだＡＭチャンネル信号に復調される。

【００１１】第１実施例で通信信号を伝送するための装置には、振幅変調されたチャンネル信号ブロックによりＲＦ副搬送波を周波数変調する手段と、ＲＦ副搬送波で光搬送波を変調する手段と、及び光ファイバーの様な光通信経路へ変調された光搬送波を伝送するための手段が含まれている。変換手段は光搬送波の輝度変調のため周波数変調されたＲＦ副搬送波を適当する周波数範囲に変換する。周波数変調及び変換手段はプッシュプル動作モードに接続された一対の電圧制御発振器で構成されている。

【００１２】振幅変調されたチャンネル信号ブロックが発振器対に入力し、発振器の出力に接続された２重平衡混合器の手段が変換された周波数変調ＲＦ信号帯を供給する。周波数変調の直線性を改善するため、電圧制御発振器はマイクロ波周波数範囲で動作させられるので、この場合振幅変調されたチャンネル信号ブロックは約２０ＧＨｚの搬送波の中で極く小部分を占めるにすぎないのである。

【００１３】第１実施例の受信装置は、光通信経路からＡＭチャンネル信号ブロックにより周波数変調されたＲＦ副搬送波を含む輝度変調された光搬送波を受信する手段から構成されている。光搬送波から周波数変調されたＲＦ副搬送波を取り出すための手段、及び振幅変調チャンネル信号ブロックを取り出すため、副搬送波をＦＭ復調するための手段が備わっている。取り出した周波数変調副搬送波を復調のための適当する周波数範囲に変換するため、復旧手段とＦＭ復調手段間に接続された手段も備わっている。また復旧した振幅変調チャンネル信号をテレビジョンセットまたは類似装置に供給する手段も備わっている。

【００１４】第２の実施例ではＡＭチャンネル信号ブロックが光搬送波の光学振動数を変調するのに使われている。光搬送波は絶対振動数値にリファレンスされており、このことは受信機側で弁別器を適正に動作させるために必要なことである。第２実施例で光学振動数変調信号に対しての受信装置としては、受信した光搬送波から振幅変調されたチャンネル信号ブロックを取り出し、相当する輝度変調光信号を出力する光ＦＭ弁別器で構成されている。また受信機には例えば映像及び音声情報からなる振幅変調されたチャンネル信号を復調するための手段も備えられている。

【００１５】

【発明の実施例】本発明は光通信経路を通じて光搬送波を送信するため、通常のＡＭチャンネル信号のブロックで、ＲＦ副搬送波をＦＭ変調することにより、低ＣＮ比と歪成分を達成できる利点が生まれるのである。光搬送波はＦＭ送信のための適度なレーザー回路の直線性とＣＮ比の条件を備えてレーザーから供給され、例えばＣＮ比が約１８ｄＢならばＦＭ送信に十分で、また第２と第３次複合歪成分は約２０ｄＢ必要とするのみである。これはＡＭ送信に必要とされる４０ｄＢぐらいのＣＮ比に比して全く有利である。

【００１６】本発明は光ファイバーケーブルテレビジョンシステムに関連させて説明してあるが技術に精通した方々ならば、本発明はその他の光通信網に応用できることを認めることができるであろう。

【００１７】発明の最初の実施例を図１から図４に図示してある。図１で明らかな様に現行ＡＭケーブルテレビジョン帯１０には約５０ＭＨｚから約５５０ＭＨｚの間に、６ＭＨｚの周波数配分で個々のチャンネル信号が含まれており、将来的には帯域幅は約１ＧＨＺまで拡張されることが予想できる。現行周波数帯１０はブロックコンバータ１４に端子１２から入力する。

【００１８】本発明ではブロックコンバータ１４にはＡＭケーブル周波帯でＲＦ副搬送波を変調するための周波数（例えば２．２ＧＨｚ）に対しての広帯域ＶＣＯが含まれている。ＡＭケーブル周波帯による周波数変調はマイクロ波の範囲の周波帯で行うのが有利であり、この場合テレビジョン搬送波のブロックの帯域幅は電圧制御発振器の操作周波数に比較して小さい。

【００１９】ＦＭ変調副搬送波はローパスフィルタ１８でフィルターされた後、レーザー２２を直接変調する。通信システムの必要条件及び光ファイバー回路による制限に従って、ファブリー ペロー形又は分布帰還形（ＤＦＢ）又は量子井形の様な周知構造のレーザーが使われている。もちろん外部変調又はその他の輝度変調をこの光信号の変調に使用することができる。

【００２０】図１の実施例ではファブリー ペローレーザー２２が周波帯２０を含むＲＦ副搬送波で輝度変調される。この結果、テレビジョンチャンネル信号のブロックを含む輝度変調された光搬送波が生成され、光ファーパー網２４を経て光ファーパー受信機２６に伝送される。

それゆえレーザー２２からの光搬送波出力は高周波領域内でＦＭ変調された元のＡＭケーブル周波帯を含んでおり、光通信路を通じて輝度変調信号を伝送することになる。こういうわけで輝度変調信号は光－ＡＭ／ＲＦ－ＦＭ／ＲＦ－ＡＭ信号又は簡単に言えばＡＭ／ＦＭ／ＡＭ信号とみなすことができる。

【００２１】光ファイバー受信機２６は光搬送波を受信し、輝度変調された情報（この場合はＡＭチャンネル信号のブロックを含むＦＭ変調されたＲＦ副搬送波（ＦＭ／ＡＭ）であるが）を取り出すための一般的な装置である。取り出された情報は２８のブロック復調器に入力し、ミキサー３０で端子３２から加えられる局部発振周波数でより高い周波数に変換され、元のＡＭ周波帯を広帯域弁別器３４で取り出す。ＦＭ／ＡＭ信号周波数の上方変換はＡＭ周波帯の取り出しに同調回路弁別器が使用される場合は特に有利である。取り出されたＡＭケーブル周波帯１０はブロック復調器から出力される。

【００２２】広帯域ＶＣＯ１６の実施例の一つを図２の構成図で図示してある。本例では一対の電圧制御発振器（ＶＣＯ）４０，４２がプッシュプルモードに接続され、ＶＣＯで作られた副搬送波を変調するため端子１２で入力したＡＭ信号ブロックの直線性が満足できる約２１ＧＨｚの中心周波数で作動させられるのである。ＡＭ周波帯１０の５００ＭＨｚ帯域幅は約２１ＧＨｚのＶＣＯ動作周波数に容易に収まるのは明らかである。

【００２３】ＶＣＯ４０とＶＣＯ４２の出力は２重平衡混合器４４で結合され、既存通信システム中の光送信機及び受信機の両者を共用できる様にＦＭ変調ＲＦ副搬送波の周波数を下方に変換させる。このＲＦ副搬送波はレーザー２２の直接変調に使われるのである。ＶＣＯ４０，４２から２１ＧＨｚのマイクロ波搬送周波数で出力されたＦＭ変調副搬送波出力はミキサー４４でヘテロダイン化され、図１に図示したような中心周波数が約２．２ＧＨｚの信号帯２０を作る。ローパスフィルタ１８で広帯域ＶＣＯの周波帯出力から高い周波数成分を取り除く。

【００２４】図３に２重平衡混合器４４の出力での入力電圧と出力周波数間の直線関係５０を図示してある。また図４にＶＣＯ４０，４２のプッシュプルモードを行った結果の理想的な伝達特性を図示してある。線５２は入力電圧の変化に対する中心周波の上方への偏移を、また線５４は同じく下方への偏移を表している。

【００２５】受信機側では振幅変調チャンネル信号ブロックが広帯域ＦＭ弁別器３４（図１）で取り出される。この弁別器はその遷移状態を識別する簡単なローパスフィルタの様な周知の型式のものであり、一方又広帯域ＶＣＯ１６と同様な構造の２重平衡ＶＣＯも受信機側でのＦＭ弁別に使用できる他、その他の周知の高周波ＦＭ弁別器を使用してもよい。

【００２６】図５から図１０に本発明による別の実施例を図示してある。この実施例ではＡＭ副搬送波（例えば映像）ブロック情報を光学振動数変調を使って光ファイバーに配信している。図５に示した配置ではレーザーサブシステムが光搬送波を供給している。レーザーサブシステム６０からの搬送波出力は、端子６３で入力するＡＭ副搬送波ブロック１２０で光学振動数変調される。

【００２７】振動数変調された光搬送波は光増幅器６２で増幅され、スプリッタ６４に入力し、この各々の出力は光ファイバーケーブルテレビジョン伝送網中の別々の送信経路に接続されている。図５に示した経路では光学的にＦＭ変調された搬送波がファイバー回路６６を通じて光弁別器６８に達し、光搬送波からＡＭ副搬送波を取り出す。

【００２８】この光弁別器としては光遅延回路，光学フィルター，不平衡ＲＦ干渉計，波形分割多重格子および（または）誘電体フィルムの様な周知の光弁別器の技術を活用することが可能である。光弁別器６８の出力は通常の光検出器７０で検出され電気領域に変換される。得られた電気信号はＲＦ増幅器７２で増幅され通常の方法で個々のＡＭ副搬送波に復調される。

【００２９】図５の実施例に使われる光弁別器の例として図９に図示したマッハ－ツェンダー干渉計形光振動数弁別器があげられる。ファイバー回路６６からの光振動数変調光が端子１４０で入力し、不等長の２経路１４２と１４４に分割される。経路１４２は経路１４４より長いので、経路１４２を通った光が経路１４４を通った光に対し僅かに遅れる。光経路は干渉計部１４６で結合されており、端子１４８での出力信号はＡＭ副搬送波譲歩を重畳した輝度変調光を含んでいることになる。弁別器が振動数の絶対値をはずれて動作したとき、光搬送波振動数のドリフトを防ぐため、送信機側で規準リファレンスを持ったレーザーを備える必要がある。

【００３０】図１０に図９の光弁別器に対する伝達特性を図示してある。１５２として図示してある様に光弁別器が作動する領域でその伝達特性は相当に直線性を保っている。このマッハ－ツェンダー干渉計のこれ以上の説明についてはＢ．Ｈ．ヴェルビーク（Ｂ．Ｈ．Ｖｅｒｂｅｅｋ）等の“Ｓｉ上に燐をドーピングしたSiO_2導波管を組み込んだ集積化４チャンネルマッハ－ツェンダーマルチ／デマルチプレクサ”，Ｉ<u>ＥＥＥ Ｌｉｇｈｔｗａｖｅ Ｔｅｃｈｎｏｌｏｇｙ</u>，ＬＴ－６，ｐｐ．１０１１，１９８８に詳述されている。この他の光分散装置、例えばファブリ－ペロー干渉計の様なものも光弁別器として使用可能である。

【００３１】図６に図５のレーザーサブシステム６０の構成を図示してある。ＡＭ副搬送波ブロック１２０が端子８１から図２に図示したプッシュプルＶＣＯの様なＲＦ周波変調器に入力する。レーザー８４から光搬送波が供給されるが、受信機側のＦＭ弁別器で必要とする場合は、レーザー出力の中心振動数を一定点に保つため振動

数の絶対値を示す規準リファレンス８２を設けておく。光学振動数変調器８８で光搬送波を変調器８６からのＲＦ周波変調副搬送波出力で変調する。そして光搬送波は光学振動数変調波と共にＡＭ副搬送波ブロック１２０を伝達することになる。

【００３２】外部光学振動数変調器８８は変調器８６からのＲＦ変調波を光学領域波に変換する。光学振動数変調器は音響光学又は磁気光学効果を利用してその役割を担うもので、かかる装置の例は文献で述べられている。例えばC. S. ツァイとD. ヤング（C. S. Tsai and D. Young），の“静磁気前方向波を利用した広帯域被きよう導光ビーム偏向とＲＦスペクトル分析”，Integrated and Guided−wave Optics Topical Meeting,（IGWO），ヒューストン，テキサス，2月6日～8日，１９８９年，MBB３－１，pp. ２９～３１で広帯域ＲＦ周波変調信号を光学領域に変換可能な磁気光学相互作用の技術を述べている。

【００３３】またC. S. ツァイとZ. Y. チェン（C. S. Tsai andZ. Y. Cheng），が“新しい集積化音響光学による周波数シフター”，IGWO, ヒューストン，テキサス，2月6日～8日，１９８９年TuAA５－１，pp. １４２～１４５で同様な目的に使われる音響光学相互作用技術について説明している。

【００３４】またC. S. ツァイとT. Q. ヴー及びJ. A. ノリス（C. S. Tsai, T. Q. Vu, and J. A. Noris），が“イオン打ち込み法によるプレーナー導波管レンズとGaAs中のレンズ配列の形成”，IGWO, ヒューストン，テキサス，2月6日～8日，１９８９年，MDD４－１，pp. ７６～７９でこの様な変調器の光の出入を結び付けて論じており、変調器に集積化されているレンズについても明らかにしている。

【００３５】上記のツァイ等（Tsai et al）の参照文献で詳述されている変調器を採用する時は、ＦＭ信号処理利得を実際化する即ちＣＮ比を希望値まで増加させるため、最初にＡＭ副搬送波情報を広帯域ＦＭ変換する必要がある。この変換はＲＦ領域内の通常の電子回路で行われるのである。

【００３６】図７に複数の別々のＡＭ副搬送波ブロック１２０を伝達する光学振動数変調搬送波を供給する装置を図示してある。ＡＭ副搬送波ブロックは端子１２１で別々のＲＦ周波数変調器（図７では変調器１０８のみを図示してある）に入力する。その他のＲＦ周波数変調器（図示していない）の出力は別の副搬送波を収容して端子９５と１０１に接続されている。

【００３７】ＡＭ副搬送波の各ブロックは対応するレーザーにより供給された別々の光搬送波上で光学的に変調される。副搬送波の別々のブロックに対し個別のレーザーを備えることで、この光伝送システムの全チャンネル容量を増やすことができる。例えば第１の光学振動数Ｗ１（光学振動数絶対値レファレンス９０により一定値に保持することが可能）のレーザー９２が光学振動数９４によって変調される光搬送波を出力する。

【００３８】レーザー９８は受信機側の光弁別器が必要とする場合には振動数絶対値リファレンス９６で一定値に保つことのできる振動数Ｗ２の第２の出力を供給する。この光搬送波は光学振動数変調器１００で変調される。最終的にレーザー１０４が振動数Ｗｎの光出力を供給し（必要ならば振動数絶対値リファレンス１０２で一定値に保たれ）、変調器１０６で変調されるのである。レーザー９２，９８，１０４からの各変調搬送波はマルチプレクサ１１０に入力し単一の光信号に結合され伝送される。

【００３９】光マルチプレクサ１１０（及び対応する受信機側の光デマルチプレクサ）は既知技術による部品である。最も簡単な実施例ではこのマルチプレクサは波長不感ファイバー結合器から出来ている。マイクロ光格子，ダイクロイック多層誘電体フィルター，又は不平衡マッハ－ツエンダー干渉計等も全てマルチプレクサ及びデマルチプレクサの機能を備えており、例えばM. カワチ（M. Kawachi）の“Si基板上の波長分割多重集積化された導波管要素”，Conference on Laser and Electro−optics, ボルチモア，メリーランド，4月24～28日，１９８９年，FG５を参考にされたい。

【００４０】図７の実施例では光増幅器も備えられている。光学振動数変調器が非常に小さな残留振幅変調しかない時は半導体光増幅器を使用する。エルビウムファイバー増幅器が使用でき、振幅誘導漏話をより防止出来る。いくつかの光増幅器をファイバー配信システムに直列に接続して全経費の節約ができ、また信号伝達距離を延ばすことが可能である。

【００４１】図８には光搬送波の光学振動数変調をＡＭ副搬送波ブロックで行うためのもう一つの方法が図示してある。この実施例ではＡＭ副搬送波ブロック１２０が端子１２３に入力し、半導体レーザー１３２の注入電流を直接変調している。注入電流の変化はレーザー内に光学振動数チャープを発生させ、その結果ＦＭレスポンスの直線性がよくなる。

【００４２】例えばY. ヨシクニとG. モトスギ（Y. Yoshikuni and G. Motosugi）の“純周波数変調とチャーピング抑制振幅変調のための多電極分布帰還形レーザ”，Journal of Lightwave Technology, Vol. LT－5, No. 4, １９８７年4月を参照してもらいたい。

【００４３】レーザー１３２は振動数絶対値リファレンスにより絶対値を規正されており、このことはシステム

の光学振動数マルチプレクサ，デマルチプレクサ，及び弁別器が特定の光学振動数で作動することにとって必要なことである。この振動数絶対値リファレンスはどうしても備えた方が良いことは明らかであろう。このため例えば光電流効果又は気体セルが利用出来る。

【0044】例えばY．C．チャン，P．D．カーチ（Y．C．Chung，P．D．Tkach）の“コールドスタート1．5μmFSKヘテロダイン検出実験”<u>Optical Fiber Communications Conference</u>，ヒューストン，テキサス，2月6～9日，1989年，TUI5及びM．W．マエダ，R．E．ワーグナー（M．W．Maeda，R．E．Wagner）の“1．5μm領域におけるパッケージされたDFBレーザーの周波数識別と安定化”，<u>Optical Fiber Communications Conference</u>，ヒューストン，テキサス，2月6～9日，1989年，TUI4を参照してもらいたい。

【0045】本発明が従来のAM光ファイバー通信の不利な点をなくして、光伝送経路に振幅変調映像副搬送波ブロックを送信するシステムを提供しているものであることが明らかになったことと思う。光通信経路の直線性は現行システムの様な懸念される状態にはならず、AM信号は周波数変調を重ねることでAM伝送と同じ様に伝送出来るのである。

【0046】電気的領域での周波数変調における直線性はマイクロ波周波数でFM変調器を動作させることで生じるのである。2組の平衡電圧制御発振器を備えることで変調工程の直線性が増し、単一のVCOの場合に比較して利用出来る周波数偏移が倍増する。2重平衡混合器中でVCO出力を結合することで周波数の下方転換が行われる。

【0047】本発明について種々の実施例と共に説明してきたが、技術に精通した方々なら特許請求の範囲の本発明の真意と範囲を逸脱することなく、種々の広用及び改善がはかれることと思う。

【0048】

【発明の効果】本発明は以上説明したように、光通信経路を通じて光搬送波を送信するため、通常のAMチャンネル信号のブロックで、RF副搬送波をFM変調することにより、低CN比と歪成分を達成することができる。従来、多重チャンネルAM送信に伴う問題点はAM伝送の必要条件としてのCN比と歪成分が光通信システムにおいては達成することが困難であった点を解決したのである。

【0049】すなわち、従来多重チャンネル映像送信は多数のFM変調映像チャンネルの各各の副搬送波により送信されていた。しかし、映像分配に対するこのFM副搬送波変調の手法は、各チャンネルに対し送信側でそれぞれ専属の変調器と受信側に同じく復調器を必要とし費用がかかることになる。更に現行ケーブルシステムと両立させるため、この様なFM送信では適当なチャンネル分配のため周波数変換をしなければならず、このため多数の部品を使用する複雑なシステムを必要とすることになる。

【0050】本発明は、AM信号分配の利点を両立させながら、FM送信の必要条件である低CN比と歪成分の利点を伴う方法と装置を提供することにより、これらの諸問題を解決することができた。

【図面の簡単な説明】

【図1】本発明のシステムを図示した構成図である。

【図2】図1のブロックコンバータで使われている広帯域VOCの実施例を図示した構成図である。

【図3】図2の広帯域VOCの動作の直線性を示した図表である。

【図4】図2の広帯域VOCの理想的な伝達関数である。

【図5】光搬送波の光学振動数がAM副搬送波のブロックで変調される本発明のもう一つの実施例の構成図である。

【図6】AM副搬送波のブロックで光搬送波を外部光学振動数変調を行う方法を図示した構成図である。

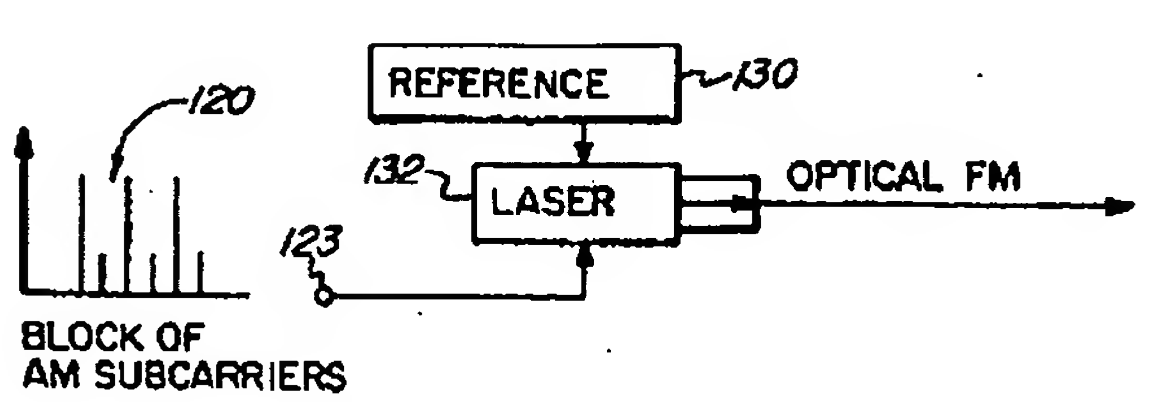
【図7】AM副搬送波の異なるブロックで複数の光搬送波を外部光学振動数変調を行う方法を図示した構成図である。

【図8】AM副搬送波のブロックで光搬送波の直接光学振動数変調法を図示した構成図である。

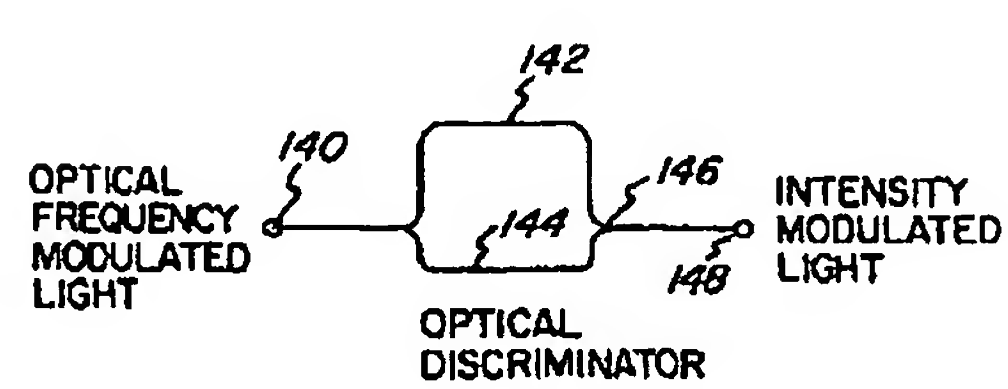
【図9】図5の実施例中で光学弁別器として使用できる不平衡干渉計の概略図である。

【図10】図9の光学干渉計の動作の直線性を示す範囲を図示した伝達特性の図表である。

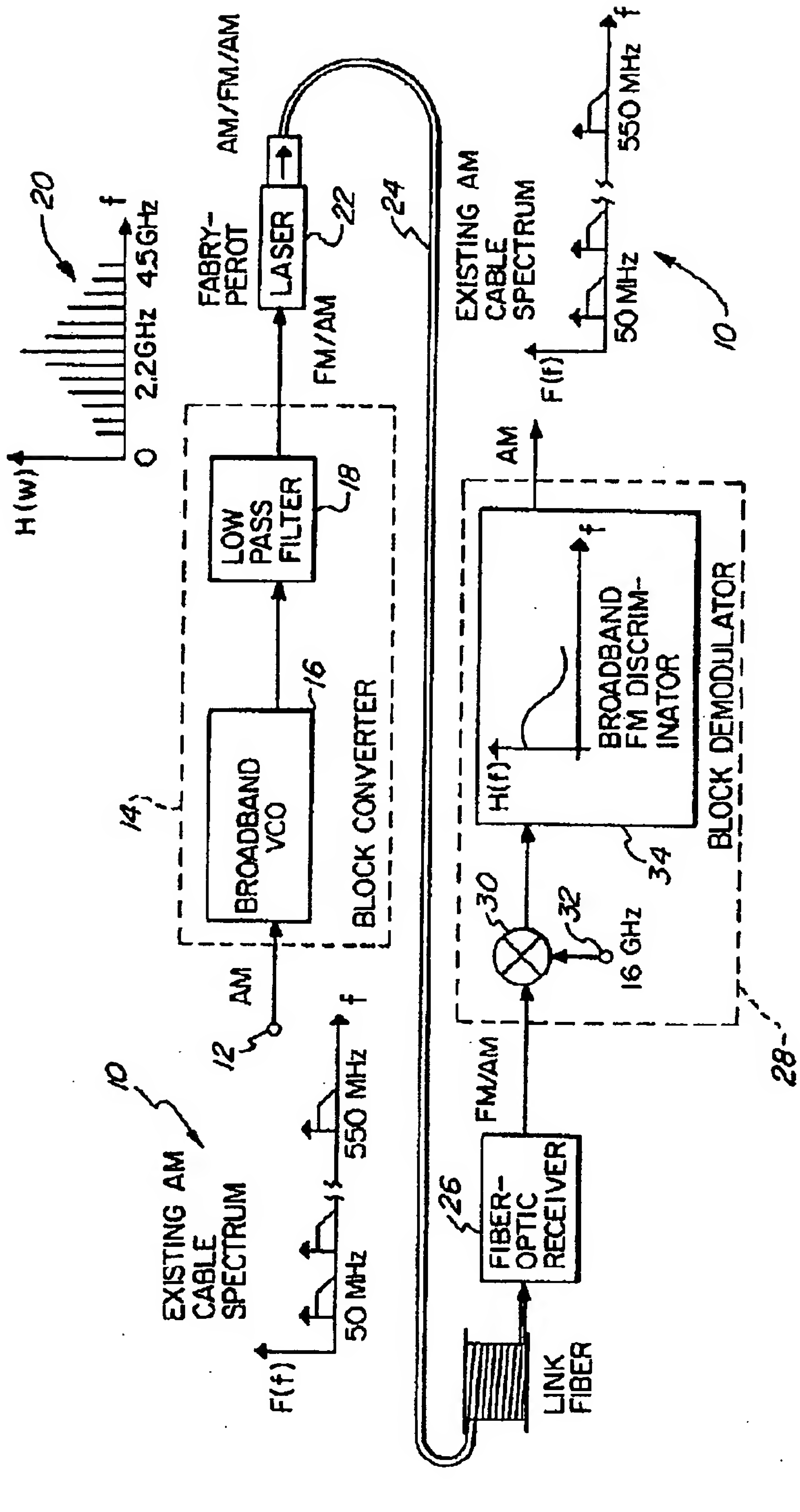
【図8】



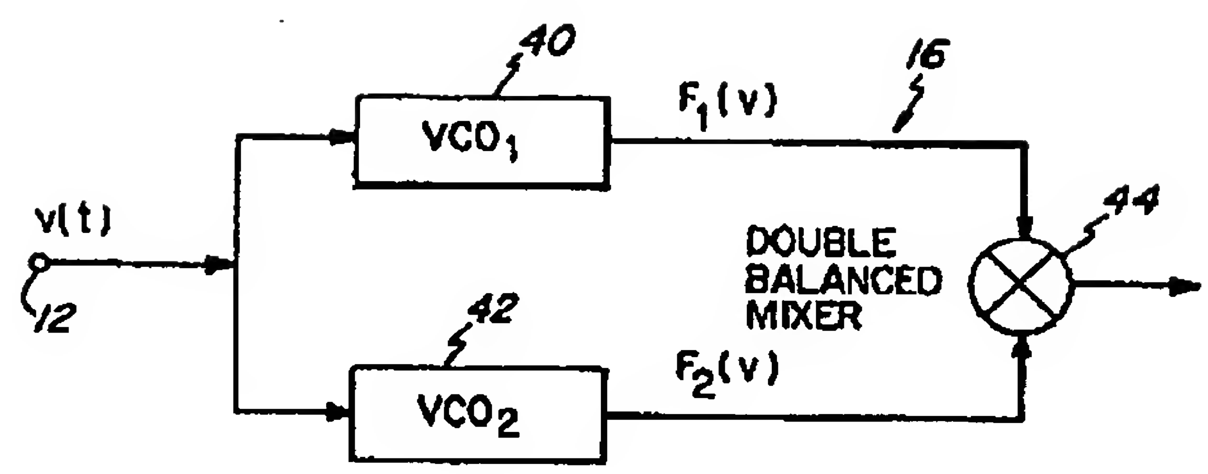
【図9】



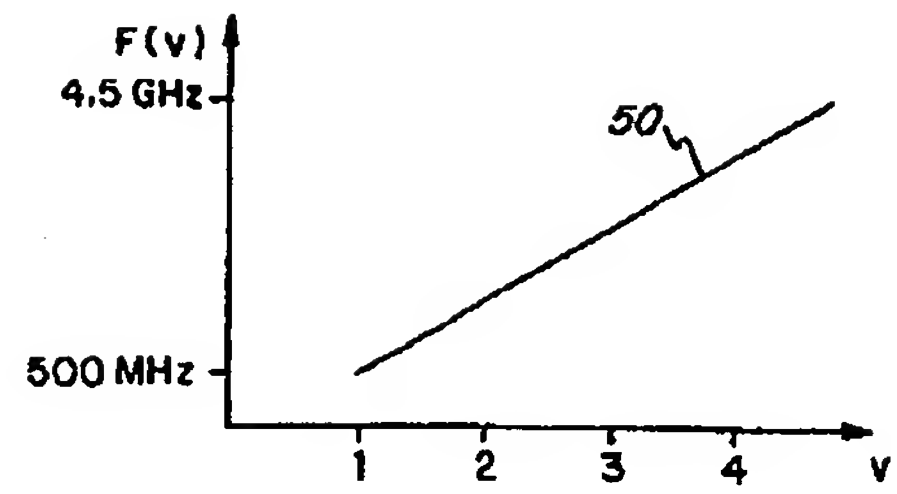
【図1】


H(w)
20
f
0
2.2GHz
4.5GHz
FABRY-PEROT
LASER
22
AM/FM/AM
FM/AM
24
LOW PASS FILTER
18
BROADBAND VCO
16
14
BLOCK CONVERTER
AM
12
EXISTING AM CABLE SPECTRUM
F(f)
50 MHz
550 MHz
10
EXISTING AM CABLE SPECTRUM
F(f)
50 MHz
550 MHz
10
AM
BROADBAND FM DISCRIM-INATOR
H(f)
34
BLOCK DEMODULATOR
30
32
16 GHz
28
FM/AM
FIBER-OPTIC RECEIVER
26
LINK FIBER

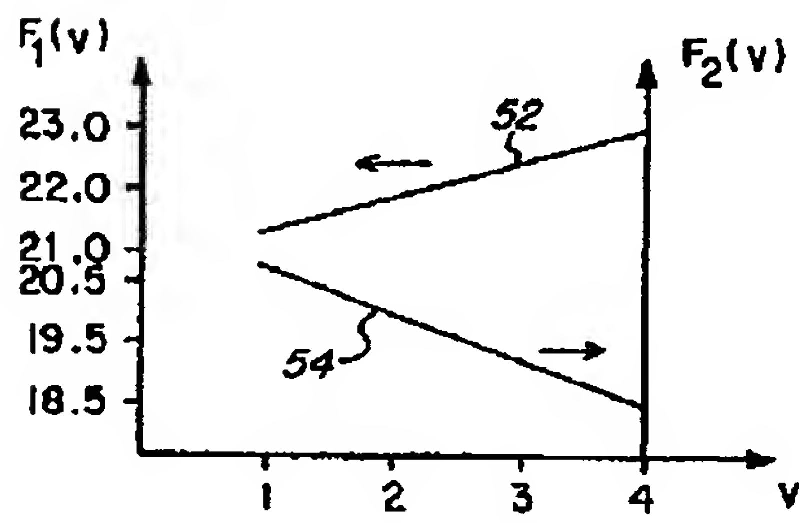
【図2】



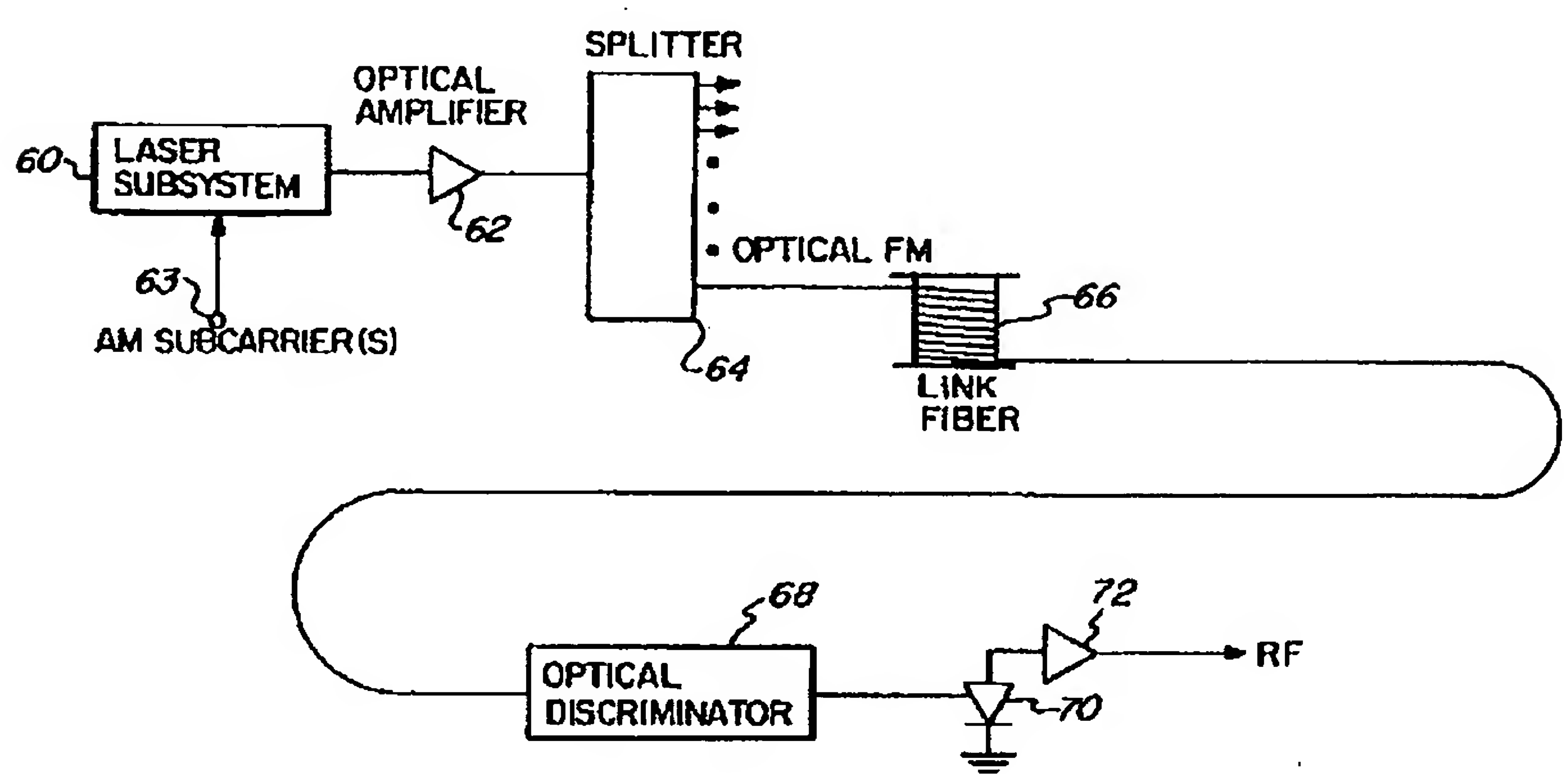
【図3】



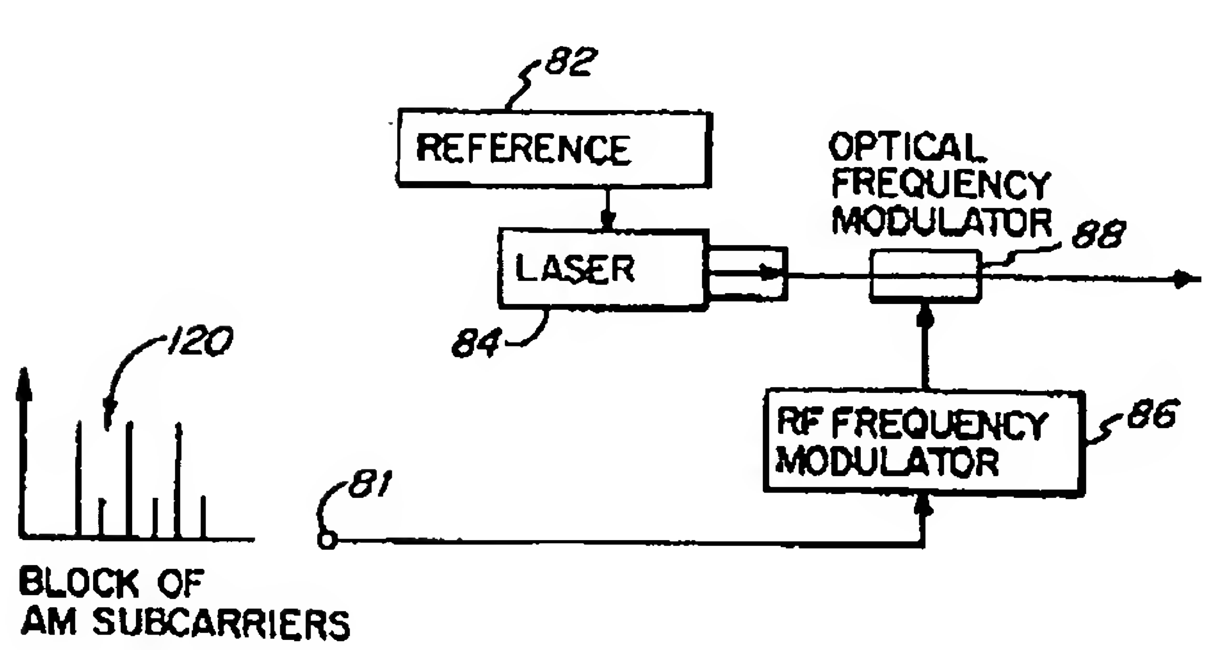
【図4】



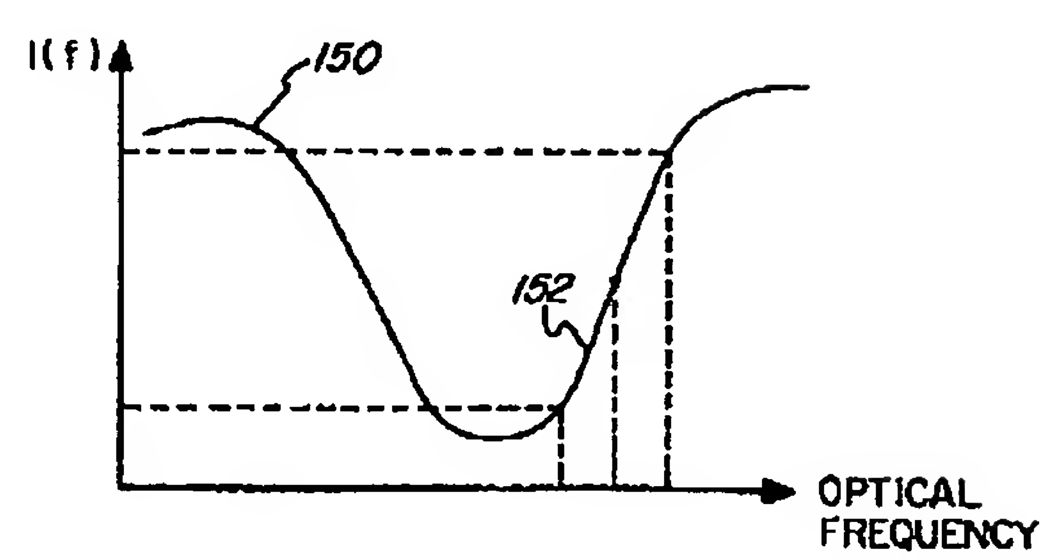
【図5】



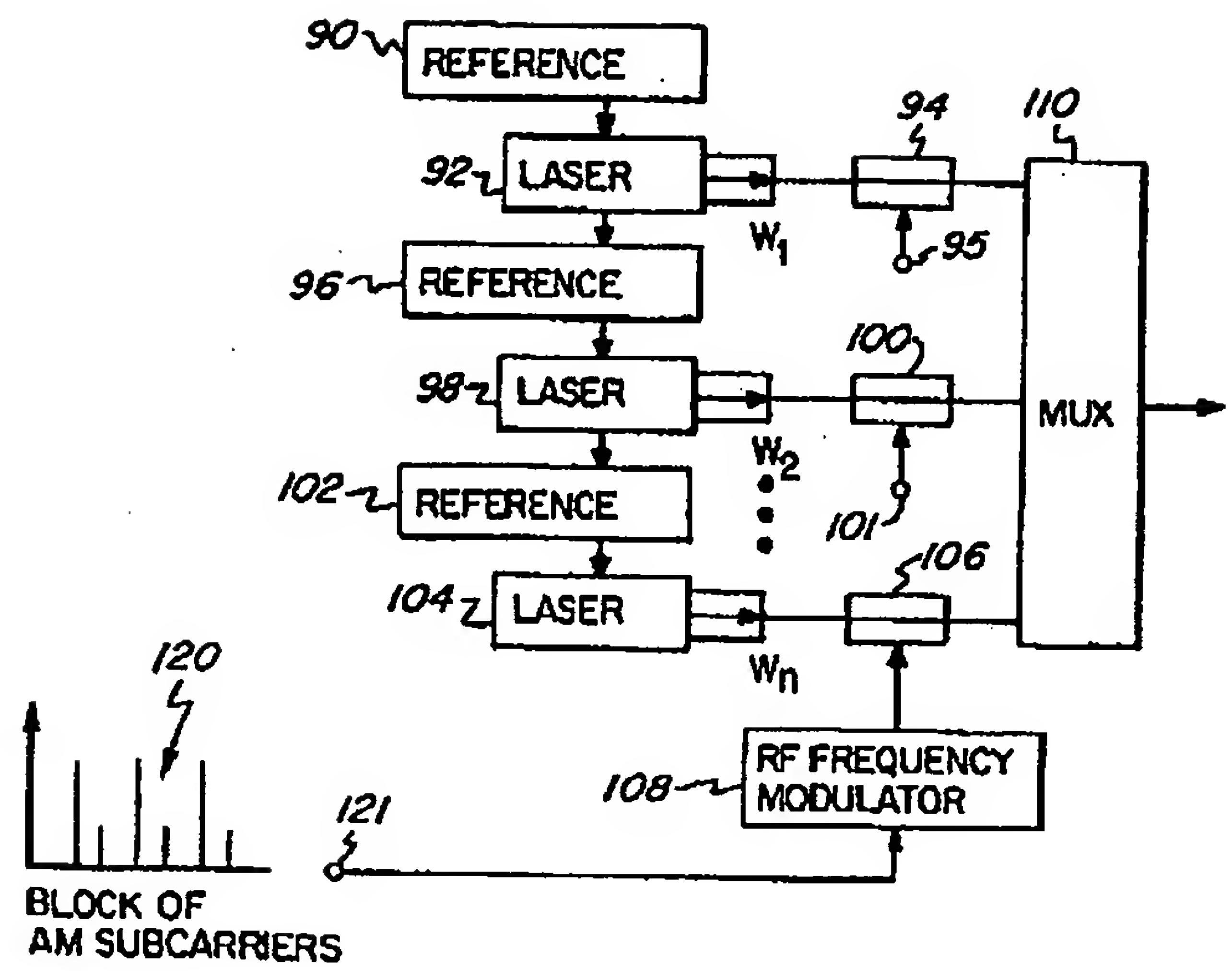
【図6】



【図10】



【図7】



フロントページの続き

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CLAIMS

[Claim(s)]
[Claim 1] The optical receiver characterized by preparing the splitter with which a type of modulation carries out frequency band separation of the photoelectric-transducer output for every same group in the optical receiver which receives the lightwave signal by which intensity modulation was carried out with the frequency multiple signal by which the carrier modulation was carried out by the type of modulation from which plurality differs, and the impedance converter which takes adjustment with the output impedance of this splitter, and the input impedance of pre amplifier.

[Translation done.]